VOL. 51 THIRD SERIES No. 5 MARCH 1944

JOURNAL OF THE ROYAL INSTITUTE OF BRITISH ARCHITECTS

LONDON
No. 66 PORTLAND PLACE W.1

PRICE ONE SHILLING & SIXPENCE

A*


KIMOLOBOARD is at present available only under control by the Minister of Works
Information gladly supplied on request.
The war board—and the post-war board.

JOURNAL OF THE ROYAL INSTITUTE OF BRITISH ARCHITECTS

3rd Series] [*Vol.* 51

No. 5 MARCH 1944

CONTENTS

A view of the Chapel of Eton College, 1843. One of a collection of 54 drawings by James Deason, 22 being of Eton and the rest mostly of buildings in Normandy, recently presented to the R.I.B.A. by Mr. James Loughborough Pearson [*Ret. F.*]

Journal

EXHIBITION OF CONTEMPORARY BRITISH ARCHITECTURE

It is the intention of the Council of the R.I.B.A. to hold an exhibition of contemporary British architecture, which, it is hoped, will be the first of a series of periodical exhibitions indicating the progress of the art in this country.

The first exhibition will be held in September, 1944, and architects will be invited to submit for selection photographs, also drawings or models, of work executed or proposed since 1935.

It is the earnest desire of the Council that members on war service should have, as far as can be arranged, an opportunity to exhibit, and an early announcement will be made concerning the method of submission and selection.

AN INFORMAL MEETING ON PREFABRICATION

An Informal Meeting will be held at the R.I.B.A. on Tuesday, 4th April, 1944 at 5.30 p.m., when Mr. G. A. Jellicoe [F.] will open a discussion on "Prefabrication." He will be followed by Mr. Richard Sheppard [A.] and Mr. A. Pott [A.], of the Building Research Station. The meeting will then be open for general discussion.

PRESENTATION TO SIR IAN MACALISTER

We regret that owing to the fact that Sir Ian MacAlister met with an accident it was found necessary to postpone the presentation which was to have taken place on the 21 March. When Sir Ian has recovered another date will be arranged, which will be announced in due course.

B*

NOTES FROM THE MINUTES OF THE COUNCIL

15 FEBRUARY 1944

Council Election, 1944

The Acting Secretary reported that the Lord President of the Council had granted the Institute Council's request for permission to hold the Council election in 1944.

Obituary

The Acting Secretary reported with regret the death of the following members and student :—

Robert Martin Holland-Martin, C.B., F.S.A. [*Hon.A.*].
Claude Somerset Buckingham [*F.*].
Andrew Gray [*F.*].
John Perry [*F.*].
Augustine Alban Hamilton Scott [*F.*].
Charles Henry Brodie [*Retd.F.*].
Frederick Clark [*Retd.F.*].
William Henry Thorp [*Retd.F.*], Class of Proficiency 1881 (Vol. Arch. Exam.). Mr. Thorp was a past Member of the Council.
Henry Gordon Atkin-Berry [*A.*].
Harold Courtenay Bishop [*A.*].
Charles Joseph Brandon [*A.*].
Matthew Starmer Hack [*A.*].
Harold Edward Wilson [*A.*]. Killed on active service.
Archibald Gillespie [*Retd.A.*].
Walter Raymond Haworth [*L.*].
Alexander Mair [*L.*].
Herbert Charles Scotto [*L.*].
Herbert Skyrme [*L.*].
George Sarbatt Noke Stone [*L.*].
William Mitcheson Timlin [*L.*].
Joseph Foley [*Student*]. Killed on active service.

Messages of sympathy have been conveyed to their relatives.

Ministry of Works Directorate of Post-War Building : Study Committees

The final Reports of the Committees on *Business Buildings* and *Walls, Floors, Roofs and Partitions*, convened by the R.I.B.A., have been submitted to the Ministry of Works.

Appointments

Demobilisation Committee :
Major V. H. Seymer [*A.*].

Architectural Science Board :
Mr. M. Hartland Thomas [*F.*] and Mr. R. N. Wakelin [*A.*].

Code of Practice Committees Convened by the Institution of Mechanical Engineers :

(a) *Fire-Fighting Installations :*
Mr. Alfred Foster [*F.*] and Mr. F. H. Durant [*L.*] (with Mr. Digby L. Solomon [*F.*].

(b) *Lifts, Hoists and Escalators :*
Mr. J. Alan Slater [*F.*].

British Standards Institution : Committee on Wallpapers :
Mr. H. V. Lobb [*F.*].

British Standards Institution : Committee on Stone Lintels, Copings, Sills, etc. :
Mr. Stanley Heaps [*F.*].

R.I.B.A. Representatives on Architects' Registration Council :

Mr. Joseph Addison [*F.*].	Mr. C. Lovett Gill [*F.*].
Mr. C. H. Aslin [*F.*].	Mr. Herbert Kenchington [*F.*].
Mr. Darcy Braddell [*F.*].	Mr. Hubert Lidbetter [*F.*].
Mr. W. E. Brooks [*F.*].	Mr. A. L. Roberts [*F.*].
Mr. A. B. Knapp-Fisher [*F.*].	Major V. H. Seymer [*A.*].
Mr. R. B. Craze [*F.*].	Mr. Basil M. Sullivan [*F.*].
Mr. J. L. Denman [*F.*].	Mr. Sydney Tatchell [*F.*].
Mr. H. M. Fletcher [*F.*].	Mr. Michael Waterhouse [*F.*].

R.I.B.A. Representatives on Admission Committee of A.R.C.U.K. :

Mr. R. B. Craze [*F.*].	Mr. D. Poulton [*A.*].
Mr. Herbert Kenchington [*F.*].	Mr. A. T. Scott [*F.*].

R.I.B.A. Representatives on National House Builders' Registration Council :
Mr. C. H. James [*F.*] in place of Mr. G. E. Streatfeild [*F.*] (with Mr. G. A. Jellicoe [*F.*] and Mr. Stanley C. Ramsey [*F.*]).

R.I.B.A. Representatives on University of London Architectural Education Committee :
Mr. Basil M. Sullivan [*F.*] and Mr. A. B. Knapp-Fisher [*F.*].

East Ham School of Building Advisory Council :
Mr. H. Lidbetter [*F.*] in place of Mr. Hugo R. Bird [*F.*], who has resigned owing to inability to attend.

Architectural Competitions

On the recommendation of the Competitions Committee the following amendments to the Regulations for the Promotion and Conduct of Architectural Competitions were approved :—

Regulation (A) to read :

" The nomination for every competition of an Assessor or Assessors who shall be architects of acknowledged standing and whose names shall be submitted to the President of the R.I.B.A. for approval and to whom the whole of the designs shall be submitted."

To the paragraph reading " The President of the R.I.B.A. is always prepared to act as Honorary Advisor to Promoters in their appointment of Assessors " add the words " . . . and it is customary for Promoters to avail themselves of his advice."

The following amendments to the " Directions for Assessors " were also approved :—

Additional paragraph to Clause 6 :

" It is suggested that an Assessor, when drawing up his award, might bear in mind the desirability of commending designs of merit which are not premiated. Such commendation would be an encouragement to a competitor and would show him that he was working on the right lines. As in the case of the premiated designs, however, care should be taken not to commend any design which in any way contravened the conditions as amplified by the answers to questions."

Additional paragraph to Clause 14 :

" It is highly desirable that the Assessor should have an interview with the successful competitor and give him the benefit of his advice."

Walcot Drawing for R.I.B.A. Collection

The work by William Walcot entitled " Egyptian Temple—Anthony in Egypt " has been purchased for the R.I.B.A. collection.

Membership

Fellowship :
The Council by a unanimous vote elected the following architect to the Fellowship under the powers defined in the Supplemental Charter 1925 : Mr. Frank McArdle [*L.*], representative of the Royal Society of Ulster Architects on the R.I.B.A. Council and Allied Societies Conference.

Membership :
The following members were elected :
As Fellows (3), as Associates (17), as Licentiates (14).

Election, 21 March 1944 :
Applications for election were approved as follows :
As Hon. Associate (1), as Hon. Corresponding Member (1) as Fellows (5), as Associates (3), as Licentiates (14).

Reinstatements :
The following ex-Members were reinstated :
As Fellows : George Alexander Allan.
Charles Herbert Reilly [*Retd.F.*].
As Associate : Cyril Edward Power.

Resignations :
The following resignations were accepted with regret :
Edwin Augustus Lead [*L.*].
William Clayton Minchin [*L.*].
William Walter Newman [*L.*].
Albert Reaveley [*L.*].

Transferred to the Retired Members Class :
The following members were transferred to the Retired Members Class :
As Retired Fellows : John Gordon Allen.
John Williamson.
As Retired Licentiate : Smart Walker.

PROF. A. E. RICHARDSON, R.A.

Professor A. E. Richardson [*F.*] has been elected a Royal Academician.

WAR EXPERIENCE IN THE ORGANISATION OF BUILDING CONTRACTS

By T. P. BENNETT, C.B.E., F.R.I.B.A.

A Paper read at an informal General Meeting at the R.I.B.A., on Tuesday, 15 February, 1944. The President in the Chair.

I am speaking to-night in my capacity as a private architect expressing views which are the result of my war experience, and I am not speaking as Director of Works.

The Architect

The Architect by temperament, training and experience is a planner and designer, possibly a colourist, and draughtsman. Architecture is an art which strives to achieve fitness of purpose in building clothed in forms which achieve proportion, texture and beauty of detail. Architecture is also " fine building," and like all arts has an aspect that is practical as well as artistic and involves much that is the essence of science and economics. In many ways architects have travelled away from this practical aspect of their work and have tended to become involved in sociology rather than in organisation. There has been a constant movement towards a position in which the architect is concerning himself with the production of buildings for a large and ever-increasing section of the population. The emphasis on architecture has moved from the point at which the sole criterion was the excellence of the finished building, irrespective of time or cost, to a period in which function, appearance, time and cost have at least equal value.

Stress on Constructional Problems

War-time building has inevitably reduced temporarily the importance of the qualities of architectural design, the use of good materials and achievements in complex planning and has created conditions in which organisation and speed have overshadowed everything else. Even in cases where design and planning were of considerable importance a high standard has had to be achieved in both without in any way sacrificing economy in manpower and economy in time. In other words, organisation to its fullest extent has been an over-riding consideration. Thus the war has shown at once the weaknesses and strength of the handling of the contract in a way which is of the utmost importance as a background for the large projects of post-war building.

Satellite Towns and Housing Schemes

Post-war satellite towns and blitzed sites will bring to the architect's office many war-time building problems in a peace guise and so this study may be of some permanent value. The great majority of works of architecture in peace were carried out on sites in towns where the question of site development was either non-existent or confined within very narrow and obvious limits. The war has shown that the undeveloped site produces problems which embrace the possibility of very substantial overhead expenditure on the buildings created, and involve the construction of roads and services which, if not well handled, will defeat the whole contract. Contractors with civil engineering experience have on the whole shown themselves much more able to cope with these problems than contractors with only building experience, and a very parallel condition has arisen in connection with supervision exercised by the architect. In post-war architectural practice many men will be called upon to deal with raw sites as they have had to deal with them in war.

Allocation of Men

Organisation must start long before the site is approved and may be complicated by controls. In war the control problem has been far reaching and has included rationing of labour and in some cases of material. Rationing of men has compelled visualisation of a very accurate nature into (a) the productive power per man for different types of buildings, and (b) the adjustment of the time which the project takes to build to the number of men who are made available to build it.

Organisation in Principle

Organisation must start with the industry as a whole; it is becoming more and more evident that a much greater amount of basic information should be available. The knowledge required under this heading can only be compiled by a body of people carrying out research in a comprehensive manner. Many such bodies exist—their work needs extending, co-ordinating and distributing. Man hours and the cost involved, the relative advantages of factory and site production, costing and statistical research, comparisons of different types of construction in man hours and cost as well as purely technical and planning research are all needed.

Increased standardisation is necessary to limit the variety of factory-produced units and to lower cost, although it may well limit the choice of the individual. A library of planned information is a necessary basis of work to-day and needs considerable expansion in view of limitations of labour and materials which will be essential for many years.

The organisation of the work of the architect will come under a number of headings which summarised give—

(a) professional information,
(b) organisation in the office,
(c) organisation on site, including a much wider knowledge of the handling of men and the problems of cost which they entail.

Limitation of Materials

Materials have been in short supply and in many cases difficulties of manufacture have been experienced, necessitating a planned programme which forecasts the arrival of particular materials on a given site in proper sequence and at a given time so that completion to time can be secured.

Limitation of Transport

Transport is a major factor, and the purchase of materials according to sources of supply has been one of the considerations which have had to govern not only the type of building but the speed at which it could be constructed.

Organisation Capacity of each Architectural Unit

Arising out of these considerations, the architect who is an organiser has tended to become more and more the key person in the execution of war projects, and in post-war work every architectural unit must have within itself this organising capacity as well as its accepted design capacity.

Individual Control

It must be evident to the whole of our profession that the acceptance of these conditions in war carries with it a potential of real importance in peace. In war, construction has tended to emphasise the position of the organiser who has applied his wide knowledge of construction together with his extensive site experience to the solution of war problems. There is a very real and serious risk that when peace problems of a parallel character are

under consideration, the constructor may claim that he is more capable of producing buildings in a given time with restricted labour and materials than is the architect who is concerned exclusively with the planning and appearance of the building. There is, moreover, a risk that the constructor may endeavour to allay public apprehension with regard to planning and appearance by appointing another man—an architect—to carry out these limited services, thereby ensuring that the buildings will have the appearance which the public considers essential, and the architect in such circumstances would cease to be the prime mover in building and would become a secondary factor.

The Architect as the Controller of Building

I believe that this is a very real and serious danger to our profession, and I believe to our country and its buildings. The architect ought to be the main controller of building, but he can only be a controller in the sense which we are now discussing if he has equipped himself to organise, to use materials with the utmost economy and expedition, and to be able to handle building schemes with their perhaps relatively uninteresting structural and economic problems with the highest type of skill. The architect is the producer of well planned, well designed and æsthetically good buildings whether they are houses, schools or factories, but it is essential that the public should regard him also as the best organiser and builder and be able to rely completely upon his ability in this respect.

It must be realised that the majority of war schemes, and possibly a very large number of post-war schemes, will be built on open sites devoid of roads and services, and having very many characteristics which are not shared by the town site bounded by existing buildings, and approached by fully established roads. As I said before, not only have many architects in war failed to appreciate this very clear-cut distinction, but a very large number of the building contractors of the country have failed in handling sites of this character because of their lack of civil engineering and contracting knowledge.

Site Report

The basis, therefore, of the post-war scheme which has these characteristics will be the site report. This site report should have a standardised form. The Codes of Practice Committee is, I believe, endeavouring to draw up such a standard at the present time. This report should have a number of headings under which the architect secures accurate site information. This site report is a pre-requisite of the site itself. Its headings may be summarised as follows :

(a) description of approaches,
(b) details of soil sewers or drainage disposal arrangements,
(c) details of surface water disposal,
(d) water mains,
(e) electric mains,
(f) gas mains,
(g) general topographical appearance of the land and whether affected by brooks or streams, trees, excessive variation of level, poor soil, existence of bushes or scrub and similar things.

The site report may well go further and indicate the availability of ballast, brickfields and other sources of basic building materials in the district. A survey in the larger cases may be necessary of transport arrangements, housing facilities for workmen and feeding facilities by means of British Restaurants. I will refer to welfare at a later stage in this paper.

The site report in war has shown itself as one of the documents of extreme value. It could with equal importance be regarded as a necessity for a town site. Some of the headings of the country site giving place to such matters as precise condition of party walls, legislation affecting lands, town planning, control of building lines and other matters so that a scheme cannot proceed any distance without the architect having made sure that his design will not be hampered by surrounding site conditions, adjacent buildings or current legislation.

Client's Requirements

Having prepared this accurate record of site work, it is then necessary to prepare an equally accurate record of the client's requirements. Again, war experience has shown that these requirements are by no means easy to stabilise. The layman has hitherto considered that as long as a structure is not actually erected he could, with impunity, change his mind or revise his requirements. We have not yet driven home to the public the fact that a building contract once commenced on the site should be regarded as immovable (as with the motor car once it reaches the production band). It should become quite as impossible for the client to alter his building or the architect to adjust his design once he has commenced building as it would be for the motor car designer to alter his ideas once the jigs have been made and the car construction commenced.

The Education of the Client

The architect, therefore, is under the obligation of educating his client by claiming his inability to accept alteration, warning the client of the loss in speed and in money if such changes occur. By questionnaire, by meetings, by preliminary drawings, sketches or models, the architect must show the building owner the kind of building which he has instructed the architect to produce.

As many post-war projects will be initiated by Committees, it is advisable to make good use of drawings and of models in order that a very clear conception of the requirements may be in the lay mind. It may be necessary for the client who will run the building to appoint at an early stage the manager, who will be responsible for operating such things as cooking equipment, so that at the inception of the project the type of equipment required may be incorporated in the plans and made part of the scheme.

Types of Contract

The contract becomes the next matter for consideration. There are two main issues which affect organisation from the architect's point of view :

(a) the type of contract, broadly speaking the division between the lump sum and the day work contract,
(b) the method of selecting and appointing sub-contractors with the drawings and description of the work which they have to carry out.

It is perhaps not sufficiently realised that a prime cost contract needs a very large amount of supervision set up by a very much earlier date and considerably more comprehensive than the head office organisation or site organisation needed for a lump sum contract.

It may well become necessary to use some type of a cost target or fee contract in post-war housing and other schemes, so that it will be necessary for the architect and the quantity surveyor to familiarise themselves with their duties and responsibility for contracts of this character. In contracts of extensive repetition such as those involved with large housing schemes, the cost contract with a target builder's fee, properly organised and ruthlessly carried out, might well prove to be a satisfactory method of producing buildings at low cost during the transition period. In such cases the architect and quantity surveyor would have to set up a checking organisation on the site so that as soon as the builder was producing houses above a certain margin on the estimated figure they would, if the organisation was considered at fault, remove the builder from the site and replace him with an efficient contractor.

With the very rapid growth of the scientific side of building within the last forty to fifty years it is perhaps inevitable that the designer-contractor should come into existence and he has proved to be an essential part of the industry. This has led, however, to cases in which the sub-contractor receives a sum of money for his specialist work exceeding an economic level, and it has moreover produced considerable dissatisfaction amongst the main contractors who feel

(a) that they secured their own portion of the work at a very cut figure,
(b) that they have lost some measure of control to the sub-contractor,
(c) that the sub-contractor is appointed at too late a date to be able to be included in a proper organisation.

Comprehensive Information

The point has therefore been driven into a position of great importance because contractors have indicated that they cannot carry out work at high speed with the minimum use of labour and materials if they are not

(a) familiar with the whole of the requirements of the building at the commencement of the contract,
(b) able to instruct all the major sub-contractors as soon as the contract is let.

Nominated Sub-Contractors

Proposals have been made that the system of nominated sub-contractors has such serious disadvantages that it should be superseded by a system specifying and delineating all the major services as part of the drawings and the quantities for the main contractor, and that the main contractor, having priced these items in the Bill of Quantities, should himself be at liberty to obtain sub-contractors for this work. Some contractors claim that they would with such a scheme organise the building much more economically than they can at present and ensure that it should proceed more smoothly and at greater speed.

Accurate Specification

There can never be a specification which will precisely differentiate between a moderate grade of achievement or construction and a high grade of achievement and the war has shown that these disadvantages, while they are well known and fully accepted by the capable executants of the profession of architecture and the industry of building, cannot be laid down in words, and if the sub-contracts were handed to the builder to sub-contract as he thought fit there is a very real fear that the quality of work would deteriorate without necessarily showing the building owner a corresponding saving in cost.

The Specialist Design

If the architect is to retain his control of building it will be necessary that he should in his own office employ structural engineers, heating, electrical, sanitary and water engineers to deal with all aspects of his work ; or, alternatively, he must have suitable consultants who will automatically work with him on the same basis and who will prepare drawings and specifications that are needed before the main contract is let. This clear-cut and precise procedure with regard to sub-contracts is an essential factor in rapid and economical building and the alternative will be a more and more insistent demand on the part of the builders that they control the sub-contractors if they are to build at the proper speed and with the minimum labour force.

The Relationship of Sub- and Main-Contractors

The relationship between the sub-contractor and the main contractor must be much more clearly defined ; the sub-contractor will have to become a signatory to the time and progress schedule and undertake to deliver and fix his material at such time as the builder shall indicate. There will have to be clauses in the contract which clearly indicate the availability of roads, scaffolding, water, heat, artificial light and other adjuncts necessary for the execution of the sub-contract as well as defining the extent to which the builder can instruct the sub-contractor to work as and when the general organisation of the building requires his services. It would be advisable for the architects to draw up a complete schedule of procedure in connection with the relationship of the sub-contractor and the builder in the contract.

Cost of Producing all Information for Large Schemes

It is quite obvious that if this measure of information is to be produced by the architect at his own cost, he cannot cover the services with a fee of 6 per cent. where the engineering equipment is of an elaborate and extensive order and it should therefore be the immediate concern of architects to examine the question of fees and the method of procedure and to decide which portion of the specialists' work it is reasonable to include in the architect's fee, it then being the responsibility of the architect to make the drawings for steel and reinforced concrete and other structural materials, if these are included, or to employ a consulting engineer to make them for him and pay him ; or it will be necessary to convince the public that where extensive heating, lighting, ventilation, acoustics and other schemes are required, it will be necessary to pay an aditional fee to the architect for carrying out this work. In small contracts, however, it may well be reasonable to expect that the mechanical and electrical knowledge needed should be known by the architect's organisation and that it is not sufficiently great to disturb the accepted fee for buildings of this character. I consider, however, that it is of the greatest importance that architects should consider this matter and should, if possible, issue a clear-cut statement to the public.

Too readily has the architect in the past been able to use the apparently free design facilities of the specialist sub-contractor who has of necessity included these design fees in the cost of the contract which is ultimately met by the client. The whole field of sub-contracting and all that it entails is ripe for consideration.

Site Organisation

The site organisation of architects and builders has not proved to have a very high level. There are of course outstanding exceptions which merely serve to throw into sharp contrast the moderate level of the average. Site organisation has achieved an importance in the war which perhaps it may not have had in peace. It has shown, moreover, that if a contract is to run smoothly from day to day there are many decisions of relatively great importance to the architect which should be made by a site representative of real responsibility. The industry has hitherto been satisfied to represent its architects or, more properly, its building owner on the site by a clerk of works, a man of industrial training, generally a craftsman, and it has not been the custom for the architect to have a professionally trained man on the site in any except a few of the largest contracts. The war has shown that the province of the clerk of works and the province of the resident architect are both different and both essential. Engineering has for a long time realised that it cannot proceed with its large projects without a resident engineer who is as capable and fully trained as the design engineer. The resident engineer has an extensive knowledge of site work, and, moreover, is employed as occasion demands by the professional office of the consultant or the industrial office of the civil engineering contractor, and therefore this resident engineer becomes a man with extensive site knowledge and experience, who can offer a real contribution to the progress of the work.

Site or Resident Architect

So far there has been no parallel in architecture—yet the necessity for a site architect is quite as great as that of a site engineer. In the country advantage should be taken of local prospect, and all the delightful adjuncts of good building which we are apt to describe as accidental. The architect endeavours to contribute this advice or control by his weekly visit ; but if work is to proceed at war speed and labour is not wasted, weekly site direction is entirely inadequate. In addition, the site architect is much more able than the office visitor to control such things as colour, texture, proper use of materials, local levels and adjustment to contours. The improvement in organisation which the contractor will experience is so great that it cannot be ignored —there is a great gain in economy if precise instructions with regard to finish are produced from day to day by a trained, intelligent and capable architect on site and the contractor does not have to wait a week or fortnight before a decision is made.

Profits on Claims

It is evident from the study of a large number of contracts that a substantial section of the building industry has fallen into the practice of obtaining a contract on a low competitive price and

relying upon extras to make its profit. These extras can arise on the contract from

(a) alterations by the client or the architect or both, which causes much bigger disorganisation and loss than the average architect will admit,

(b) the contractor may lose money through his own bad site organisation.

The site architect should have sufficient knowledge of the handling of building contracts, and particularly large contracts, to know whether the site organisation is efficient or not, knowing perfectly well that the client will have to pay for the loss. While the architect may be directing a lump sum contract he is in fact taking part in what may become a prime cost arrangement ; that is to say, the builder, before rendering his final account, may examine the prime costs of the contract, decide upon the profit which he thinks is reasonable and make out a claim which will aim at securing the difference between the priced contract and the cost plus profit which he hopes to secure. This is an entirely unsound method of working because the honest contractor who put in a sum of money in accordance with his views of the value of the work but who did not intend to make claims is very much at a disadvantage compared with his colleague who relies upon claims. Only a highly efficient organisation can counteract this defect of our industry.

Welfare

The welfare of men on building sites was shown by the war to have been in the past a matter of complete disregard to most contractors and to nearly all architects. The early days of the war produced a body of men on sites who arrived frequently wet, having come by laborious and uncomfortable transport, who were fed on the site in draughty and uncomfortable canteens, often cold in winter, and who brought their own packet of food and cooked it as best they might on the most primitive of fires. It was a remarkable feature of the early visits to war sites to find that the men considered this disregard of their welfare as part of the building industry and the contractors' agents considered it was quite ridiculous to attempt to do better, in fact, any attempt to raise the standard of accommodation on building sites was said to be a waste of money and a waste of effort and that it would not in any way be appreciated by the men concerned.

The war has produced a very big change of outlook in this direction. While, in the past, the builder has stored his cement in a shed and has protected his delicate machinery by putting it at once under cover, he has not shown the same regard for his men. Viewed purely as a problem of financial economy, it is obvious that if the men are to produce the best results of which they are capable they must be reasonably housed and reasonably fed on building sites. Their clothes, if they arrive wet, must be dried and if they are asked to work in inclement weather they must be provided with reasonable protection. External work in inclement weather has a considerable psychological background—men who are working inside under cover will not work if the outside worker ceases work and sits in the canteen while being paid for the time so spent. The march of progress therefore in connection with payment in the building industry which has involved the guaranteed week and payment for wet time has brought with it problems of caring for the men and providing for protection in difficult conditions. A factor which is of great importance from the welfare angle is the indication that the post-war world will expect 100 per cent. employment. This brings in its train a number of problems that were not evident before the war because 100 per cent. employment means employment of men over age with physical disabilities men who can never hope to give the 100 per cent. efficiency of the young physically fit good craftsmen of 20 to 50, but whose contribution to the general pool of production is by no means negligible. These men can only hope to produce reasonably if the conditions are good and if they have reasonable care and protection. We have also to consider that the pre-war world threw the disability of these men on to the State and they were taken care of by the State when they fell on periods of sickness and ill health. It therefore freed the employer, who was largely, if not entirely, unaffected by conditions of work which led to sickness. We shall be compelled to find means of co-ordinating the interests of the employer and the State so that the production of the over-age man and the disabled will contribute towards the building effort and, at the same time, will have to be included in the builders' responsibility. From a great many angles, therefore, welfare in the building industry with its care of workmen and all that it entails must become part of the machinery of building, whether it is in the town or the country.

Welfare in Detail

Welfare on building contracts falls under the heading of the following :

- Provision of Sanitation ;
- Drying Rooms ;
- First Aid ;
- The feeding of workmen, and where men are resident, the housing of workmen ;
- The general study of the conditions of living for the daily or resident worker, including protection from weather.

Considerable extension is therefore needed compared with the very elementary welfare which was generally regarded as sufficient in peace-time town building. It is by no means easy to educate an industry into a practice which is considerably above the level of that which it has hitherto followed. The standard of army welfare may be regarded as the normal basis to take, and one which the average man will accept. This has been incorporated in Ministry of Labour Factory Form 1892.

The industry itself is under a considerable difficulty in endeavouring to emulate a standard of welfare of more stable industries, because in the factory, labour is stabilised both geographically and numerically, and welfare can therefore be operated in permanent buildings with a permanent staff.

The migratory nature of the individual building contract is a major disability in dealing with welfare problems of all kinds, but particularly so in dealing with the adequate provision of feeding for the worker. In the majority of conracts labour grows from zero to a peak and falls to zero, remaining at its peak for a period of weeks or months only. It is in connection with feeding that many of the most serious problems of wartime welfare have been experienced.

The architect will be called upon to advise his client on the extent to which he should be prepared to meet the cost of welfare on sites. This in turn needs a considered policy as between architects, contractors and operatives. This standard should be decided upon in the form of regulations enforced on all building sites, so that the good owner is not penalised as against the poor owner, so that the man is not penalised as between the parsimonious client and the generous client, the local authority and the Government.

In considering individual headings which need examination on the typical country site or a town site of substantial magnitude, there will be the necessity for bus stops with provision against the weather, provision of suitable transport, erection of drying rooms, and the introduction of a system of supervision, receipt and issue of clothes, proper provision of latrines and washing facilities, the latter having hitherto been practically non-existent.

In the case of the development of satellite towns or the extensive repair of blitzed cities, migratory labour is almost certain to be forced upon the community, and in this case an accepted standard for sleeping accommodation with provision of baths will become a necessity. This involves also recreation and matters connected with the comfort of the men who may have to spend weeks or months in a labour camp instead of in the comfort of their peacetime homes.

The standard accepted during war conditions may not be acceptable in peace, and it is therefore desirable to have an accepted standard which is known to all and which is incorporated in the contract.

Whether there is residential accommodation or not the provision of an adequate midday meal is a necessity. More and more

contractors have taken in hand their own organisation for feeding and have established a Welfare Department with a catering section, able on the one hand to supply to the contract the necessary equipment and on the other to produce the personnel and management which are needed to serve food well and economically from day to day.

Many of these provisions for feeding have needed some measure of subsidy from the builder. If such assistance is needed in peacetime contracts the profession will have to decide the extent to which the client can be expected to subsidise feeding and allow it to become a charge on the contract.

Similarly, the provision for working in inclement weather, if there is payment for a guaranteed week, would need to be studied in connection with the provision of suitable clothing, the method of payment for clothing, the issue and return and protection against loss, and the cost of the time during which the contractor issues and receives the clothing if it is a daily or weekly issue to the site.

Summary

I have endeavoured to enumerate certain headings upon which a close investigation of wartime practice will provide a basis of organisation in peace-time work, and I have endeavoured also to draw a parallel between the conditions of many war-time contracts and the conditions which may be expected to operate on housing sites, town reconstruction and many other obvious circumstances of post-war building. The recommendations could be stated under the following headings:

(a) Necessity for the provision of a much greater amount of technical data and statistical information, details of alternative methods of construction, differences in man hours construction, differences of cost of certain types of constructive equipment, prefabricated and otherwise, recognised and efficient means of distributing this information in a readily usable form.

(b) The need for the development of office organisation in connection with the production of the details of the design, the placing of contracts for the work of specialists and sub-contractors, the method of properly co-ordinating these sub-contractors with the main contractor, and detailed contract arrangements.

(c) The establishment of an Architect's Works Organisation of a high standard which may possibly mean the creation of a resident or site architect as a branch of the profession hitherto largely neglected; of supervision of an architectural quality, which will be able to give day to day decisions on such matters as levels, topography, texture, finish of materials colour, construction, and other similar matters.

(d) The development of cost consciousness on the part of the architect with its corollary, cost knowledge, to the level of an accurate science which will have detailed experience of the relative value of alternate means of producing a similar result.

(e) So good and reliable a reputation for building inspection that the public accept architectural control as synonymous with sound building construction and with that meticulous day to day inspection which is needed to ensure that the client has a structurally sound building.

(f) Familiarity and knowledge of the work of running contracts which will enable the architect to be of real value in collaborating with the builder on the method of executing the contract, and a profession which has a real interest in the well-being of the site personnel and means of securing from the site organisation that 100 per cent. efficiency which will be demanded by a post-war world.

DISCUSSION

In the discussion that followed the following points were made:

THE PRESIDENT in thanking Mr. Bennett suggested that we might swing too far over to the business organisation and efficiency side of architecture. He did not believe that an architect designing a great building, such as a cathedral or a town hall, could get everything on paper before the building started; some of our best buildings would never have been erected if that had had to be done. Even architects who ran their offices on what may be called business lines would agree that, in the case of certain buildings, they must have time to consider various matters after the building had been begun and that they could do that without detriment to either the building or the time occupied in its erection.

The vote of thanks was moved by Mr. J. L. DENMAN [*F.*], who referred to the vast opportunities before the profession which would undoubtedly entail revolutionary changes, but the artistic side of building must survive. He also said that public interest in building was at a higher level now than ever before. In all towns and villages discussion groups were considering the problems of rebuilding. Also the interest shown in the report issued by Mr. Bossom and his colleagues was evidence of the attention being paid to these subjects by the public.

SIR ERNEST SIMON seconded the vote of thanks. In re-echoing a remark of the President that Mr. Bennett's Paper had been provocative, Sir Ernest asked what was the appropriate adjective to apply to the report issued by Mr. Bossom's committee? In the course of his remarks he dealt in some detail with various questions—chiefly those relating to the cost of building—which both Mr. Bennett and the Committee's Report had raised. The building industry, he said, was to be congratulated on having members who could produce such reports and such a speech as Mr. Bennett's, which was based on the author's remarkable war-time experience. It was interesting and controversial but at all points constructive.

MR. MICHAEL WATERHOUSE [*F.*], *Hon. Secretary*, asked whether the site architect might not provoke rather than diminish the claims of the contractor—giving the latter an excuse for suggesting that if he had been allowed to run the job in his own way no money would have been lost.

MR. EDWIN WILLIAMS [*F.*] referred to the work of the Building Research Station and the need for more knowledge of its activity in fulfilment of Mr. Bennett's suggestions of the need for greater spread of technical information. He also emphasised the need for definite training schemes for clerks of works who were inclined to feel bitterly that they were expected to acquire their experience as well as they could —this was not good enough to-day.

Mr. Williams also expressed a fear that architects might fall into the hands of a new body of "organisers."

MR. R. F. RIDING [*A.*] welcomed the idea of a site architect, who would make more possible the intelligent modification of a building in course of erection. Few buildings could be completely designed in every detail prior to the start of building. The site architect's job would provide a magnificent outlet for the energy and ability of many young architects.

MR. ALFRED BOSSOM, M.P. [*F.*] referred to Sir Ernest Simon's comments on the report of the committee on U.S. building methods and organisation and defended their estimates of cost of building here and in America.

He welcomed the controversial nature of Mr. Bennett's paper and urged that the architect must lead in the building drive and warned against the promoter who stood between client and architect. He praised the great work of local authorities but suggested that we should not allow the local councillors to be always in a position to tell the architect what he had to do.

In reply, MR. BENNETT said that there were buildings to-day, as there always had been, which may be regarded as great works of art.

They must be developed in the way that the architect or artist found most convenient for his particular technique. Frequently it was impossible to design them entirely before the contract started or to avoid adjustment to circumstances and to the site and the material which the architect could see, as the building grew, were desirable. His comments had reference particularly to the fact that much work in the immediate post-war period would be work in which cost to the nation and the individual, and speed in housing and providing such buildings as schools would be very nearly paramount.

With regard to the question of the control of the site architect over the builder, it was, of course, a principle of lump-sum contracts that the builder carried out the work as he himself thought best for his own costing and his own building, but the big contribution of the site architect would be that he would make decisions from day to day, instead of making weekly or even fortnightly visits, which frequently constituted the kind of control which a building contract had from us now. The site architect could also criticise the builder's organisation without dictating to the builder alternative methods; he should be entitled to say to the builder that the means by which he was carrying out the work indicated a loss; and that when it came to the question of claims there would not be any.

The question of clerks of works was one which needed study by our profession as a whole. It was true that clerks of works were asking for more training, but it was equally true that clerks of works could be trained; in other words a great deal of their value arose from the years which they had spent as craftsmen.

A Note on Post-War Fenestration

By P. J. WALDRAM, F.S.I. [L.]

Under the compulsory universal town planning which we have been promised architects should be enabled and will, therefore, be compelled, to revive the lost art of efficient fenestration, rendered useless some two centuries ago by the advent of unrestricted overbuilding.

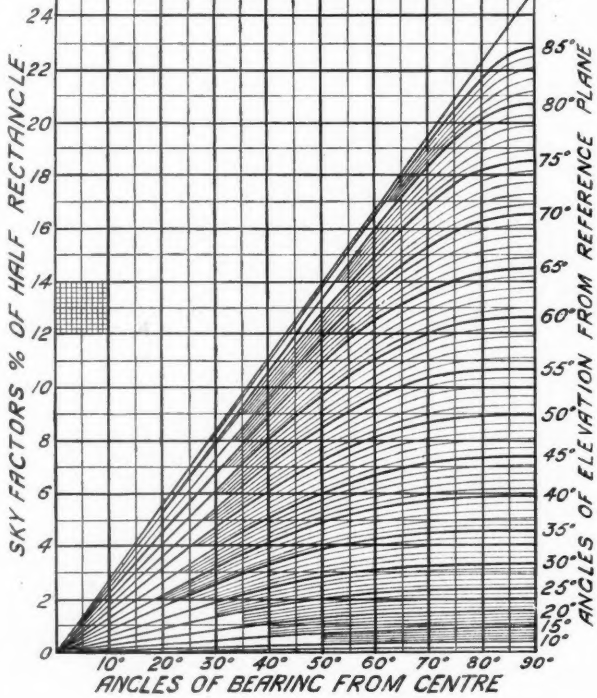
It has been suggested, however, that from official tables in course of preparation by the D.S.I.R., giving the lighting capacity of standard sizes of steel windows, designers will be able to select the dimensions of efficient post-war windows as readily as they select from tables the scantlings of floor joists.

For the preparation of these tables D.S.I.R. officers have, we are told, devised various approximate short cuts, instrumental, geometrical and mathematical, to short circuit what is supposed to be the tedious labour of using the rectangular measuring diagram hitherto officially recommended.*

Apart altogether from any doubt as to the possibility of solving many, if not most, of the practical problems arising in fenestration by tabulated data, there is no justification for approximate substitutes for the exact measuring diagram by which the daylight expert solves all his problems, simple or complex. For the comparatively simple data promised the diagram itself, which involves tedious labour only when applied to tedious jobs, provides a modification which not only reduces calculation but eliminates it; and furthermore produces the information in a form far more useful and practical than tables.

If only to restore the unjustly libelled reputation of what may eventually be an everyday tool of architects, as it is to-day of daylight experts, a brief description of this modification may be timely. It has not previously been published.

The areas of sky visible from, and therefore illuminating positions at different distances back from rectangular windows, either unobstructed or facing horizontal obstructions, are themselves rectangles and, therefore, all plot on the measuring diagram as quadrilaterals bounded by co-ordinates of angles of bearing and elevation. The areas, and therefore the sky factor values, of such quadrilaterals can be calculated exactly, and plotted once and for all on a master graph, Fig. 1.



With the aid of a slide rule and a table of tangents it is a simple matter to tabulate the angles subtended at different positions back from the centre line of the sides and head of openings of different dimensions. On the master graph, Fig. 1, the sky factor value of openings of these dimensions can be read off directly and plotted on graphs, e.g. Fig. 2, for different distances back, say every 2 ft. back to 20 ft.

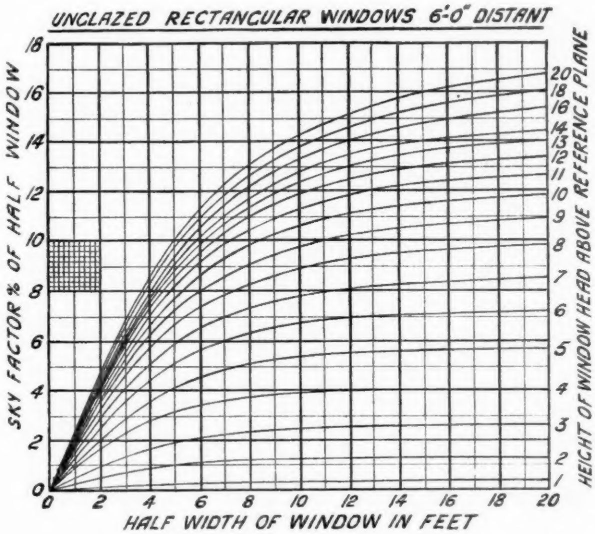
On such a series of position graphs the architect has more than all the information conveyed by tables, because tables seldom fit exactly the dimensions required, and arithmetical interpolation is troublesome and not always accurate. On graphs, however, intermediate values can easily be read off, and this is invaluable in the inevitable trial and error of practical design.

It might be considered that position graphs such as Fig. 2, being confined to the sky factor value from unobstructed windows at points along the centre line only, would be of little assistance, but the information obtainable from them is not thus limited. It extends to positions off the centre line and to the reduced lighting capacity of windows facing horizontal obstructions or their equivalent. Fig. 3 is a typical contour plan showing the effect on the lighting of a large ground floor room lit by a window 3 ft. wide by 6 ft. high above the table or reference plane by the suburban

* Penetration of Daylight and Sunlight into Buildings. D.S.I.R. Illumination Research. Tech. Paper No. 7. 2nd Ed. H.M.S.O. 9d.

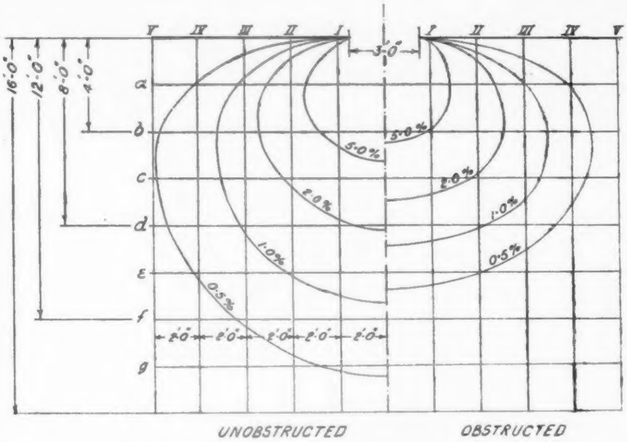
criterion of permissible obstruction of a continuous building line 80 ft. distant and 40 ft. high above the ground, which in this case is 10 ft. below the window head.

Such contour plans are set out by the method which surveyors employ on contour maps of undulating ground, viz., "spot levels"



of sky factor values are measured at all the intersections of the predetermined grid and on sections set up along the grid lines in two directions the required contour values are located, transferred to the plan and lined up. All the "spot levels" for such a plan can be read off direct from a series of position graphs such as Fig. 2.

Consider, for example, the sky factor value at the intersections 1c, Fig. 3, 6 ft. back from the window, 2 ft. to the right or left of the centre line and therefore 6 in. beyond the reveals. The sky factor value would be half that of a window 7 ft. wide less half that of a window 1 ft. wide. This would also be true for all intersections on line 1, viz., 1b, 1d, etc. Similarly, the sky factor value for all intersections on line 11 would be the difference between half of windows 11 ft. and 5 ft. wide (i.e. between half windows 5 ft. 6 in. and 2 ft. 6 in. wide). For all intersections on lines iii, iv and v the half window widths to be read off the graph will be 7 ft. 6 in. and 4 ft. 6 in., 9 ft. 6 in. and 6 ft. 6 in. and 11 ft. 6 in. and 8 ft. 6 in. respectively. On the unobstructed side all these will be 6 ft. high.



The effect of a horizontal obstruction as viewed from a reference point at a given distance from the window is merely to raise the virtual sill level. The extent of such raising can be fixed by drawing a line on a section to scale from the top of the obstruction to the reference point and noting where it cuts the glass line, or more speedily by calculation. Thus all the C points 6 ft. back from the window will be obstructed by a horizontal building line 30 ft. above the window head, 36 ft. above the table plane and 86 ft. distant up to a line $\frac{36 \times 6}{86}$ or 2.5 ft. above the table plane at sill level.

The obstructed sky factor value at 1c is, therefore, the difference between two half windows 3 ft. 6 in. and 6 in. wide respectively, both 6 ft. high less the difference between two similar half windows both 2 ft. 6 in. high.

The sky factor values at points 1c can, therefore, be read off direct from the position graph, Fig. 3, as follows:

Unobstructed 4-0.6 = 3.4.

Obstructed 3.4-(1.15-0.2) = 3.4-0.95 = 2.45.

The value at all other grid intersections can be read off a series of position graphs similar to Fig. 2 and will be found to correspond exactly with values calculated from plottings on the measuring diagram.

In the *Builder* of 30 January 1942 a series of position graphs at 4 ft. intervals up to 20 ft. was published, but as these are for windows up to 20 ft. wide only, instead of half windows up to 40 ft. as Fig. 2 their use for contouring is limited. It is hoped that a set of position graphs at 2 ft. intervals up to 20 ft. similar to Fig. 2 to a conveniently large scale will be published at an early date.

SCHOLARSHIPS IN ARCHITECTURE 1944

The following Scholarships in Architecture are offered by the Architectural Association School of Architecture, London :—

The Leverhulme Scholarship

This Scholarship provides the opportunity for students who could not otherwise afford it to obtain qualifying training over a period of five years for the profession of Architecture. It is of the value of £1,000, and its provisions are as follows :

(1) Payment of tuition fees. (2) An annual allowance of £10. (3) Maintenance allowance of £20 for travel in the British Isles during the fourth year. (5) An allowance of £40 for travel abroad during the fifth year.

Candidates must be of British nationality, must not be below the age of 17 years, and should have reached School Certificate standard. They may be required to sit for a written examination on general subjects and to come before a Selection Committee for an interview.

The Minter and Sir Walter Lawrence Open Entrance Scholarships

These scholarships, value £75 12s., entitle the holder to free tuition for the first year course at the Association's School of Architecture, and they are open to candidates who are under the age of 19 years on 1 July of the year in which they compete.

All entries must be accompanied by a portfolio of drawings, and must reach the Secretary of the Architectural Association, 36 Bedford Square, London, W.C.1, on 1 June in each year in the case of the Leverhulme Scholarships, and on 1 July in each year for the Open Entrance Scholarships.

Application forms and further particulars may be obtained from the Secretary of the Association, to whom all communications should be addressed.

THE INFLUENCE OF NEW DEVELOPMENTS IN CONSTRUCTION ON ARCHITECTURAL DESIGN

By M. HARTLAND THOMAS, M.A. [*F.*]

A Paper read at a Meeting arranged by the Architectural Science Board on Saturday, February 12, 1944.

A considerable field has already been covered by the present series of lectures sponsored by the Architectural Science Board, but a very much larger expanse of country remains to be explored, and it is perhaps appropriate to pause for a while and reconsider some of the reasons for our participation in these occasions. The connection between Architecture and Science —in the modern sense of natural science founded upon experiment —has not always been as close as it should be, but it remains one of the declared aims of this Institute, as witnessed by the original Charter.

To point the moral rather a happy instance came over the radio the other day. It was in the introduction to a talk upon the history and uses of blood transfusion. Describing the early experiments in intravenous injections at the meetings of the Royal Society, one member was said to have been outstanding with an experiment which involved the injection of wine and beer into the veins of a dog, which inebriated the dog. The broadcaster identified this experimenter by saying that he is better known to-day as the designer of St. Paul's Cathedral.

Sir Christopher Wren graduated from science into architecture. Some of us, who have not been so wise as he in the order of our education, are eager to repair the omission under the auspices of the Architectural Science Board. The title "*Architectural* Science Board" is important. This paper will be largely concerned with the implications of the word "Architectural" in this connotation.

Potted Science

It may with some justification be objected that these science lectures are merely packets of potted science for the architect, which with imperfect knowledge in any particular branch he will apply at some considerable risk. Potted they are, admittedly —even, perhaps, in the interests of portability, dehydrated. Your committee, quite unashamedly, in the conferences beforehand at which lecturers are briefed, asks for short cuts and useful approximations, that an architect can employ at the sketch design stage, long before the scientific experts are called into conference. For it is important both that approximate provision for the specialist should be made beforehand, and that the architect should have enough acquaintance with all the branches of science concerned in his design to explain his requirements to the experts, and to understand their advice.

Potted science can equip the architect to preside over a team of experts. But it could so equip anybody else. An architectural education is not a pre-requisite for the absorption of potted science—in fact, with its emphasis upon taste and imagination, it is probably a disadvantage.

The Artistic Conception

There are some who fear, and rightly, that the present emphasis upon teamwork in design, and upon the architect's function as the co-ordinator of experts, might lead to the disintegration of architecture into its component parts. It is not our purpose to assist in such a disintegration. Admitted that the time has passed, and long passed, when one man, however brilliant, could carry in his own person sufficient knowledge to produce good architecture unaided. But the importance of the artistic conception persists. Indeed, the artistic conception, the vision of a building project in its entirety, as a whole, is unavoidable. It must be seen as a single idea by somebody at some stage in the work. It is the concern of architecture that the vision should be seen early, seen clearly, and seen whole. It is our concern to contribute something to the mental equipment of those upon the rightness of whose vision so much depends.

There are few architects who would not admit the need among us for a deeper understanding of the true function of the component parts of a building. Only thus can the development of architectural form be released from mere convention—falsely sometimes called "scholarship"—on the one hand, or protected from the assaults of fashion on the other.

Carried-Over Forms

Negative evidence for the existence of fundamental thinking at the back of a design can be provided by the absence of derivative or carried-over forms. Conscious imitation is not meant, such as the lining-out of plaster to simulate masonry, or the surfacing of asbestos-cement by some photographic process in reproduction of oak. It is the unconscious inability to think in terms of the new material or the new problem, so that the habitual appearance is carried over into the new conditions. The history of architecture offers many instances of this weakness in human ingenuity, and. such is the facility with which artistic refinement can reduce appearances to our liking, the resultant forms are often held in high esteem.

An early instance of carried-over form is the Egyptian reeded column, in which the stonework retains the form of the bundles of reeds that preceded it.

The most famous of all is, of course, the Greek Order, which clearly exhibits in marble its derivation from timber construction, modified by the addition of terra-cotta dressings, before translation into stone. This is not to say that appropriate changes were not made at the transitions. For one thing, the shortening of lintel spans was unavoidable. And refinements were introduced —both optical, such as the use of fluting to make cylindrical surfaces more clearly identifiable; and emotional refinements, such as the choice of profiles according to their position and the imagined work that they were called upon to perform. Indeed, it is admitted that the Classical Orders had already in the fifth century B.C. attained a perfection of form never since equalled in the design of the Orders, still less surpassed. Can it be that, if the Athenian architects had first gone to school in Ionia, where experimental science was then being born in the liberal climate of the Greek colonies, before expending their brilliant ingenuity upon the perfection of obsolete forms; then the subsequent history of Classical Architecture might have been one of sustained and orderly progress, instead of many centuries of repeated imitations never attaining again to the original perfection of Athens?

The carry-over of architectural form in the Greek Orders was largely influenced by religious considerations as the most elaborate buildings in the Golden Age were the temples. It was felt that if the new temple was too unlike the old, the god would not recognise it and return to dwell there again at the reconsecration. A not dissimilar emotion persists to this day in

the preference for the Gothic arch for religious buildings, no matter how unsuitable the material, as in the windows of many a corrugated iron mission church, or the location, as in the wilds of a tropical jungle, or the recent R.A.F. chapel in North Africa.

Modern Instances

Modern instances of this tendency to carry over old forms into a new situation confront us on all sides. The multiplication of minor examples is perhaps more illuminating than a sketch of broader tendencies. An instance often noticed is the misuse of rusticated stonework for the casing of a steel structure. In massive walls there was a risk of the edges of the ashlar blocks spalling off in the lower courses. This was prevented by chamfering those edges. Such chamfering also served the purpose of emphasising the size and thickness of the stones, so that this and other forms of rustication came to be the accepted treatment for the bottom storey of a massive building. To carry this treatment over to stonework that is mere facing to steel was either thoughtless, or a deliberate falsification.

But it is important not to be hasty in ascribing an apparent carry-over to mere copyism. For example, the grooving out of granolithic paving in small squares, which appears to imitate stone setts, has two reasons appertaining to the newer material. One is to release the surface tension to avoid cracks, the other to prevent slipping.

A type of carry-over that is common is where the newer material has no particular shape, due to the exigencies of the material itself, and is so tractable that almost any modelling can be imparted to it. Cast iron is one of these. In the last century iron masqueraded as wood treillage, ropework, logs with the bark on, masonry, and many others ; so that modern designers pass over in contempt what is by nature an excellent and versatile material.

Coming nearer to the present time, one notices the meagre size of the panes in standard steel sash, and of the panels in standardised tea-shop style plywood panelling. The meagre proportions are a carry-over from the limitations of the previous material.

Structural Examples

The tendency to carry over is by no means confined to matters of architectural form in the restricted sense. It also appears in structural practice. For instance, the almost universal provision of a slight fall to asphalt flat roofs. There is not the least need for this, and the grading is an addition in labour and materials. The asphalt, indeed, would be better preserved for a little water standing on it. The slope is a carry-over from sheet metal construction.

A fairly common method of wall construction is reinforced concrete frame with brick in-filling to the panels. This is not a logical way of using moulded concrete, which so easily runs in broad masses of continuous walling, doing duty here as pillar, there are beam, and elsewhere merely as weather protection. The unnatural restriction of concrete into posts and beams of small section is a carry-over from steel frame with brick in-filling.

A very recent example is the compilation of tables of properties for standard sections in aluminium alloy. These sections are to be of the same shapes as those already in use for steel, although the newer metal with its different physical properties—such as a lower modulus of elasticity—demands a new range of sections proper to itself.

Another not so recent example comes from the early welded steel multi-storey framed buildings. It is customary in riveted construction to change the section of a stanchion at a few feet above the floor level, so as to avoid the complexity that would result if the cover plates to the stanchion and the bearings of the girders occurred together. This position for the change of stanchion section, with its awkwardness for internal finishes, was unthinkably maintained in the early welded versions. In later examples, the change occurs where it should, at the level of the floor girders.

Engineering Examples

To move on to an example where the architect probably had no part in the definition of the form of the new invention, consider the electric light bulb. The choice of a point source for the emission of electric light gave birth to a whole industry whose sole function has been the attempted rectification of that original error. The intolerable brilliance of the filament concentrated at a point has had to be masked, reflected, shaded, filtered, concealed—half a century of lost efficiency and elaborate botching, which is only now drawing to a close with the recent introduction of the fluorescent tube : and all because the inventive engineer could only think in terms of artificial light sources that had gone before him—the individual flame from candle, lamp, and gas-jet.

This tendency to carry over forms after they have lost their meaning is, as will have appeared from the last example, by no means confined to architecture. To go further afield, take an ordinary table spoon. Many generations ago the manual craftsman used to make the bowl and the handle separately, and then to braze the two together. Nowadays they are stamped or moulded in one piece, but on nine out of ten you will still find the rat's tail on the back of the bowl which used to effect the junction between the two.

We architects are often advised to take as our models for functional design the products of the mechanical engineer. But what do we see ? Why is the engine of the automobile placed at the front, in spite of all the problems in transmission of power to the driving wheels at the back ? It is not there, as some argue, to keep the driver's toes warm, nor as a shock absorber when he encounters a lamp-post. The motor-car is still the "horseless carriage," as it was dubbed at its introduction ; the ghost of a horse still trots in front of the driver, who, to prove it, measures the capacity of his mechanical ghost-horse in terms of "horse-power."

The railway coach shows a similar carry-over. We are accustomed to the queer little compartments each with its separate door, and take them for granted. But who, confronted with an empty shell of a coach, would subdivide it for seating in such a curious manner ? Reference to early railway prints supplies the explanation. There we find on the first coaches a painted line on the outside in a series of sagging curves, marking off each compartment at the bottom to a shape reminiscent of the curved underside of the old stage coach. It is of course, a carry-over. We rub knees in our cramped compartments because Pickwick rode that way. It is a wonder we are not still expected to clamber up on to the roof when it is full inside !

Weakness of Invention

Enough has been said to indicate that this tendency to carry over obsolete forms is not the peculiar shame of architecture, but a widely-spread weakness of man's invention. It is often due to superstition, or else to conservatism (which is a compound of superstition and lethargy), but most of all to the difficulty of fundamental logic which is a very real barrier to the attainment of clarity in design. Every designer who has made the attempt to discard habitual forms and to solve a problem from the logic of the situation alone, knows well how easily his pencil runs along the well-worn lines. That is the easy way ; and unfortunately, it is made still easier by the resources of modern technique. There is always a material or a technique available to make a passable construction out of an ill-conceived design. For instance, there is scarcely any limit to the loads and spans attainable in steel construction, but it is quite another matter to make exactly the right demands upon the steel constructor. It is not enough for architects to sit back and accept the results of science like ripe plums falling in our laps. We must ourselves acquire enough of the scientific outlook, and become sufficiently well acquainted with the theories and experiments that lie behind the results, to assess the value to architecture of the many different products and methods that are presented to our notice. Unless we do this, there is always the risk of taking one aspect of science and running it for a short time as an architectural craze, just because

somebody of great knowledge and persuasiveness read a paper on that subject to the Royal Institute, and its novelty took us all by storm. Usually it is something that should not have been new to us at all. An instance of this was the craze a few years ago for insolation. The architectural press was at that time replete with elaborate diagrams and machinery for measuring the number of hours per day during which the sun might, if not obscured by cloud, shine into a particular window, and how far it would strike into the room ; sunshine was for a time the main factor in the design of every house ; and the craze ran on until the term "sun-trap" was added to the vocabulary of house-agent's English.

Just as crazes are bad in the profession at large, so the individual architect has no business to specialise in any one branch of science to the exclusion of the others ; or rather, he abdicates from his function as an architect if he does.

Course of Study

It is with these considerations in mind that the Architectural Science Board embarked upon a very wide course of subjects for these lectures. Some of the subjects so far attempted have been Soil Mechanics, Lighting (natural and artificial), Weathering, Ventilation, Hygiene, Heating, Sound Transmission. The method of dealing with each subject that is asked of the lecturers in conference beforehand is first to give a broad impression of the present state of knowledge on their subject, second to pack in as much hard fact and illuminating illustration as will go, and third to give some simple rules and approximations for rapid use at the sketch design stage. The subjects dealt with in this manner have been diverse, but they all have their bearing upon architecture and each contributes towards a deeper conception of the art. After those that have a general bearing on design, although the list of possible titles has by no means been exhausted and will be returned to later, we have turned in the present series to subjects that have a more direct bearing upon the construction of buildings. These have been concerned with the three main materials for constructing the skeleton of a building —timber, metal, and reinforced concrete—and are well suited to prompt some broad reflections upon the influence of science upon architecture, and structural invention upon architectural form.

Similarity of Form

These three methods of construction are, as we have seen from the three lectures that we have attended in this series, approaching a similarity of form that should be particularly acceptable to architects—the architect's function being to conceive the building project as a whole in all its implications—for we now find that structural theory is coming to meet him half way, in offering structures that are primarily conceived as a whole, rather than as the sum of separately calculated parts. Let us summarise the three lectures from this point of view.

Timber

Mr. Reece, in his lecture on New Developments in Timber Construction, paid us the compliment of presenting a closely-reasoned theoretical analysis leading up to conclusions of more immediate utility to the architect. The clarity of his explanation was so illuminating that an understanding of the inner behaviour of timber under conditions of strain can now become part of the architect's mental equipment. It would not have been so valuable had he merely listed the new developments, such as Stress Grading, Laminated Construction, Ring Connectors, Adhesives, and the rest, given a few figures for working stresses and ended with a run of pictures showing examples of recent structures employing the new methods. That would have been a superficial approach, which does not really meet the architect's needs. The list of new developments, and the illustrations of recent uses would merely have whetted his appetite, and might have prompted inappropriate applications of the new methods owing to imperfect understanding. As for a table of working stresses, these belong to the detailed checking of a design, and not to the original conception of it, which is the highest function of design. The analytical knowledge presented in Mr. Reece's lecture, when fully assimilated, can become part of the unconscious mental background of architectural design in timber. For the details I must refer you to his lecture, which will be published, but here is a synopsis.

Timber, though one of the oldest of materials for the craftsman, is, owing to the lateness of its scientific analysis, one of the newest in potentiality. A comparison of strength-weight ratios (which are a useful avenue leading to strength-cost assessments) between timber, metals and plastics, shows timber best in flexural rigidity (that is, for all components lightly loaded in relation to size—slender columns, long beams, stressed skin construction), stronger than steel in tension, weak in shear, and, as plywood with a plastic adhesive, good in compression, and best of all again in bending. This analysis confirms most of the traditional uses of timber, except that members have tended to be larger than necessary, and, more significant, the use of timber struts but steel ties in a truss is a reversal of their respective best properties.

Two reasons for this reversal are given—knots which hitherto unpredictably, diminish tensile strength, and joints which are made by cutting away part of the member's cross-section. These two faults of timber construction can now be overcome by stress grading, which by statistical method gives quantitative values to qualitative judgments upon samples from a batch ; by laminated construction which allows the average instead of the lowest strength to dictate the working stress ; and by the use of the new and stable adhesives, together with the inter-surface connectors, to design joints that develop the full strength of the member.

The use of the plastic adhesives means to timber construction what welding means to steel construction, namely, the possibility of rigid frame or one-piece construction—whether it be the laminated arch, or the plywood box girder with rigidly connected uprights, or the stressed skin of the Mosquito wing.

The "Redux" adhesive, not long released from the secret list by the Ministry of Aircraft Production, which can join metals to timber, as well as to metal, by specific adhesion, points the way towards the design of composite one-piece structures in which metals, timber and plastics are combined, with each in its most advantageous situation.

Metal

Mr. Moon's lecture on Welded Steel Structure followed a different pattern. The research work upon welding is not recent, as with timber, but was elaborated many years ago. The reason why welded structures are not common in this country is that their use has been deliberately stifled by a price ring (reminiscent of Breakages, Ltd., in Mr. Bernard Shaw's play "The Apple Cart") designed to maintain in use the capital equipment already established for riveting. The stress of war has forced the adoption of the more economical method for war production, and it is hoped that the many thousands of trained welders available after the war will exert sufficient pressure for their skill to be employed.

Mr. Moon began by stating that a weld is the natural method for joining metals, and instanced the wedding ring, which is welded by hammering. Continuity of homogeneous material is the characteristic of a weld, so that the welded structure becomes one piece of metal. The rigid framework is economical (some 20 per cent. of weight is saved), and it expresses the inherent character of steel, which is first of all strength, and furthermore, strength with lightness and slenderness. Welding develops the full allowable load to best advantage—if one part is overstressed the stresses tend to redistribute themselves—with the result that the peculiar character of steelwork is most clearly brought out by welding.

This emphasis upon the "character" of the welded construction was a marked feature of the commentary upon a very ample series of illustrations. The intellectual and æsthetic satisfaction that welded construction affords the designer is a strong recommendation for the addition of the welded method to the architect's vocabulary.

Much encouragement was given to any architect desirous of making the attempt to think in terms of welded frame, by the story of a small structure shaped as half a decagon (or a Mansard roof on posts), in which the original choice of steel section by the simple graphical method of the load line parabola, was confirmed by four subsequent analyses in ascending order of complexity. Mr. Moon gave other useful approximations for the sketch-design stage, and revealing explanations of technique, for which reference should be made to the published version of his address.

The examples shown ranged from multi-storey structures, in which advantage was taken of the savings effected by continuity of girders and stanchions ; to two-pin and three-pin arches of small and large loading and span ; and to north-light and monitor-type tree-form structures ; and ended with a series of bridges of arched or girder, or mixed arch and girder, shape, in which last the magnitude of the structure compels, as it so often does, a faithful presentation of the essential possibilities of the material and method employed.

One particular bridge had evoked a comment which has great significance. It was a two-pin frame with legs sloping outwards. in the form of approximately three sides of an octagon, so that its classification would be partly a girder and partly an arch. The cleanness of the welded platework and the evident rightness of the tapered legs, and of the disposition of material generally, so impressed an experienced craftsman that he exclaimed that it gave him the same feeling as did the interior of a vaulted cathedral. In both cases the unity of the structure and the rightness of the form can impress the beholder with a satisfaction that is at the same time intellectual and emotional.

Concrete

Mr. Parry's lecture is too recently in our minds to require more than a short synopsis. The possibilities of reinforced concrete for monolithic design are a commonplace, but it is not so well understood that the design of the formwork is a master factor. We used to be told that reinforced concrete is a "plastic" material, in the sense that it can be moulded to any shape. So it may be, but the timber and steel used for the moulds are rigid, and if the would-be designer of reinforced concrete could be persuaded to think in terms of formwork, he would come much nearer to using this material in its appropriate fashion.

The most important characteristic of design arising from the best use of formwork is simplicity and continuity of line or pattern. Special shapes were said to be easy to make provided they run in the direction of repetition, and not against it.

The monolithic character of the material is further emphasised by Mr. Parry's insistence upon the rhythm and continuity of operations—whole columns and walls should be poured in one operation ; the use of sliding forms was significantly described as, in effect, fabrication by extrusion. His deprecation of imitation finishes, and of subsequent working of the surfaces by chemical applications, hammering or rendering ; and his recommendation of surfaces straight from the mould, after attention to clean joints between lifts and a good face, remind us that reinforced concrete is a material that merits respectful understanding of its possibilities by the designer.

Unity of Form

There emerges from the consideration of these three materials, Timber, Metal and Concrete, in their present stage of development, a suggestion of the unity of structural form. That unity is, of course, a fact of nature, but the fortunate situation at the present time is that the current technique of structural method serves to bring out that unity, instead of to obscure it. Rigidly framed structures are total structures, imagined from the first as coherent wholes, rather than by the laborious juxtaposition of many component parts. One is no longer to think in terms of stanchion plus beam, or pier plus roof truss, or wall plus floor (each being separately calculated), but to return to a conception of building that is in some ways primitive, and imagine the whole structure as one piece, as did the builders who in the past might have used the simple cruck for pillar and roof-tree combined.

But it is not to be merely a return to the primitive. We have the resources of mathematical analysis to assist our understanding of form. The unity of that analysis can be a partner to the unity of artistic conception. The closer we study the structural theory, and the results of research into the nature of materials, the better shall we cultivate that instantaneous feeling for correctness of form. The parabola of resultant forces is a mathematical conception, but it portrays a physical fact, and is an example of how science can furnish the artist with a pictureable idea to give intellectual meaning to emotional appreciations of form.

The Lamp of Truth

John Ruskin, in his "The Seven Lamps of Architecture," named one of his lamps "The Lamp of Truth." The principle was good, but his applications of it were superficial. He found all his seven lamps best tended in Italian Gothic architecture, and his influence caused that very alien style to be much imitated in this country. As an example of truth, he would praise the Gothic arch with its hood-mould around it, clearly defining the upper limit of the arch-stones ; and he would blame the Classical arch in which the voussoirs run up into the coursed ashlar above. Had the conception of the resultant parabola been available to him, he might have advocated truth in architecture with more reliable exhibits.

A significant justification of the parabola occurred in a bomb-damaged church. The parts of the chancel arch and wall, that were less firmly held in place by the resultant of pressure, were shaken down by the shock, leaving the profiles both of the underside of the arch, and of the top of the walling above, in distinctive parabolic form.

Truth in architecture is not merely a matter of approving one form of arch as "true," not even the parabolic and condemning others as false ; nor yet is it mere frankness of structure, achieved by exposed steelwork or unceiled timber roofs. Nor, again, is it the narrow interpretation that its critics used to lay upon Functionalism, as if the meticulous assessment of all the "practical" factors in a design could automatically dictate the solution. Practical considerations must, of course, have their place, or the design does not begin to qualify at all ; but the rightness of a design needs to be readily understood—and felt.

If the exigencies of structure do not require one form more than another, then the refinement of shape follows the demands of emotion. The distinction in Greek mouldings between the upright wave for the crowning mould, and the reversed wave for the supporting mould, is an example where the emotional understanding of the situation takes command, for there would be no serious risk of the marble spalling off if the upright wave were worked in the supporting position, but that would feel wrong to the eye.

On the other hand, when the demands of the eye are in conflict with the proprieties of structure, then the eye must be taught by the mind. The eye must learn, for example, that the sagging line of a fish-belly girder is not weaker, but stronger for its greater depth where the bending stress is greater. In the same way, a two-pin arch should be deep at the supports, shallow around the points of contraflexure, and deep again in the centre. It is an offence against the intellect, and bad education for the understanding eye, to smooth away that undulating profile, which should be characteristic of the two-pin structure, out of deference to a preconceived æsthetic.

The Architecture of Humanism

But why, it will be asked, is this of importance ? May we not let taste be the final arbiter, provided that stability and convenience have had their due ? It is because architecture has a contribution to make to man's realisation of his environment. Architecture can surround civilised man, as it does to-day, in a world of shams, deadening his susceptibility of intellect and feeling ; or it can give him enclosures that portray the forces of nature in a manner that his mind and spirit can apprehend. The distinction between intellect and emotion is very largely

one of verbal convenience. One has heard mathematicians exclaim upon the beauty of an abstract proposition. So it is not out of place to demand that a work of art should seek intellectual and emotional justification at the same time. Truth in architecture, the true functionalism founded upon scientific understanding, can provide the much-needed intellectual backbone to æsthetics. It removes æsthetic understanding from the exclusive province of the æsthete, and makes Everyman a participator. For the answer to the question "Does it work?" can be given to any man who knows how to tinker with his motor-bike; and to go on to the question "Does it look as if it works?" is no very hard step to take. But it is a step of supreme importance, for there is the Architecture of Humanism—an architecture within the comprehension of the ordinary man who is able to understand its simpler message to him, but at the same time an architecture that at higher levels of understanding admits of limitless intellectual analysis and emotional refinement—and, most of all, has the potentiality of achievement more splendid than anything that has gone before. The welding craftsman, who felt himself to be in the same line of tradition as the cathedral builders of the past, voices clearly a latent demand for the true Architecture of Humanism, and warns us to stop our ears to the demands of the pedants and the æsthetes who claim to speak in the name of Humanism.

False Prophets

Among the pedants is the art historian. He has been arguing for the return, in the name of Humanism, to adventitious ornament in architecture. It is not a disinterested appeal. It is from the convenient labels afforded by ornament that the insensitive pigeon-holing mind can catalogue the exhibits in his museum, and lead round the parties of reluctant school-children, telling them that the dog's-tooth is "Norman," but the strap-ornament is "Tudor." Unless modern architecture is to be prematurely relegated to the museum, this appeal for the return of superimposed ornamentation must be refused. And remember that architecture was at its lowest ebb in the whole of recorded history, during that part of the last century when the art historian was supreme.

A similar appeal that appears to have more weight in it, but is none the less superficial, is the æsthete's advocacy of a return to the cult of the Picturesque—in the landscaping sense of the direct appeal to the eye. (It may be noted in passing that these specious appeals to step aside from the main stream of architecture always involve a "return" to something or other in the past.) The advocates of "landscaping" our cities in the manner of "the picturesque" would admit any object, and any form however debased, provided that the self-conscious æsthete could go into a squirm about the pictorial effect of a certain vista seen from a particular point of view. Of course, the visual appeal is important, but that way would produce an æsthetic without any backbone at all, powerless to resist the assaults of controversy or the vagaries of fashion.

As will be recognised, I am joining issue here with the current policy of *The Architectural Review*, chiefly for an exaggerated stress on the visual appeal which is bordering upon the ridiculous. The cover design of the February issue is, however, an example from the past of just that union of science and art that I am advocating in this paper. It shows an exquisitely drawn human skeleton, closely annotated, leaning in an easy attitude against a classic pedestal. The *Review's* comment is quoted:

> ". . . visual intensity is combined with an equally strong emotional intensity. The skeleton is not placed before us stiff as a doll—which is what an anatomical primer of to-day would do—but in an attitude as though it were a live being stripped of its flesh. There is a great value to the student in such a presentation. . . ."

Splendour

The pedants and the æsthetes are men of straw, easily dismissed provided they are recognised. More serious is the risk of a popular revulsion after the war from anything that savours of "austerity," and an insistent popular demand for everything that is lavish. This is what happened in Russia when the lean period of the Revolution was past. Functional architecture—the product of the keenest architectural minds of a generation in search, through simplification, of essential rightness of form—has gone into battle-dress as Utility Building. There is a risk that this may be the end of that great adventure.

The post-war craving for splendour must, nevertheless, be served. There is nothing dishonourable about it. Indeed, it should be encouraged, for it will nourish and keep strong the popular determination to rebuild all our world to a better design. But if the disenchantment, that was so characteristic of the "twenties," is to be avoided this time, the splendour must be of a different kind. Then it was the "conspicuous waste" advocated by a certain school of economics. (Adventitious ornament is but an example of conspicuous waste.) Now the very magnitude of our task must, in the manner of its achievement, provide the splendour that we crave. Science must give us a deep understanding for that splendid achievement, and our understanding of it must find its clear expression by art.

RECENT EXPERIENCE IN THE DESIGN OF TIMBER STRUCTURES

By PHILIP O. REECE, A.M.Inst.C.E., A.M.Inst.M. & Cy.E.

At a Meeting organised by the Architectural Science Board on February 5, 1944

Historical

Timber was used as a structural material long before the development of the mechanical sciences and long before any adequate mathematical processes were available for the purpose of design. From the nature of the material it follows that we have little in the way of lasting monuments of early timber engineering, but there can be no doubt about its early and extended use. The pre-historic structural engineer worked under very strict limitations: for compression and shear he had stone and baked clay, for tension he could use hide or ropes of dried grasses, but for bending there was only one material he could conveniently use in its natural state and that was timber. It was readily available over large areas of the earth surfaces, it could be floated down rivers to where it was wanted and could be dragged along the ground by the most primitive means without involving any of the major difficulties of transport which must have confronted the builders of the Pyramids.

If we associate the birth of timber engineering with the piled foundations and lake dwellings of the neolithic period, and if we put the date at about 8,000 years, B.C., the interesting fact emerges that for nearly 10,000 years man had been erecting timber structures without knowing the first thing about the theory of their design, for it was not until the year 1678 that Robert Hooke established the fundamental relationship between stress and strain which is essential to the solution of the most elementary problem in structural theory. In this respect Galileo at the beginning of the 17th century was in no better position than his neolithic ancestors, as neither he nor they could produce a

satisfactory theoretical solution to the simple problem of the loaded cantilever.

We see then that the structural use of timber of necessity became an art long before it could become a science, men learnt by the process of trial and error and out of the accumulated experience of generations a technique evolved which in a large measure has been handed down to us to-day. Timber became the material of the craftsman through sheer necessity that the fact that it has to such a large extent remained the material of the craftsman rather than the mathematician is of profound significance in its effect on our modern outlook on timber construction.

This historical background provides a striking contrast with that of steel. The Bessemer and open hearth processes which made an abundant supply of iron and steel available at a moderate cost came in the few years around 1860. By this time the mechanical and mathematical sciences had become very firmly established indeed. The foundations of those engineering subjects known as Strength of Materials, Theory of Structures and Theory of Elasticity were already well and truly laid, and mathematics had provided all the essential tools. Steel soon became the mathematician's ideal material, it fitted, more or less, all his necessary simplifying assumptions. Its elastic properties were approximately the same in all directions, that is to say, it was isotropic. It was homogeneous and one piece was on the whole much like another. Engineers could very easily deal with such material and if asked what size a certain beam should be they did not have to bother about what their grandfathers had done before them : it was a matter of calculation rather than craftsmanship and a slide rule and a book of tables supplied the answer.

Even as science facilitated the use of steel so the extending use of steel gave impetus to the further development of science. The two went together, until the terms " Structural Engineering " and " Structural Steelwork " almost meant the same thing. In the course of time the field was broadened to include reinforced concerte and then the alloys. At the present time one might be forgiven for thinking that the tendency is to include plastics almost to the exclusion of everything else. In the welter of new materials timber has suffered some neglect ; scientific regard for it has been somewhat belated, and in this country at least it was not until after the last war that any attempt was made to undertake organised research into its possibilities. One result of this is that we are faced with the paradox that although timber is one of the oldest of our materials it is one of the newest in potentiality.

Comparative Efficiency of Structural Materials

As the range of available materials expands it becomes more and more necessary to establish a means of critical analysis to determine the proper uses of the materials available. So far it has not been necessary to establish a very rigorous system for structural engineering as general requirements have been so easily met by steel or reinforced concrete. In the future, however, there is every indication that the competing claims of the light alloys and plastics will make such a system necessary. The competition of rival materials has been a marked characteristic of aircraft engineering for many years with the result that comparative analyses have become an accepted feature of design. It is significant that in such circumstances timber still holds its own in aircraft construction and this fact alone warrants an attempt to define the position of timber in the hierarchy of building materials.

The exigencies of the war and the necessary operations of Timber Control have already forced us to think along these lines in our search for timber substitutes. In considering specific uses of these substitutes it is not unusual to find that they have certain disadvantages. This in itself is not surprising as it is only for those purposes for which timber had established a superiority that we now require to find an alternative. Under wartime conditions the disadvantages of substitutes have to be weighed against other considerations such as economy in shipping space and so on, but it is worth while noting the general headings under which criticisms of substitutes usually fall. In general these may be stated to be :—

1. The necessity for specialist labour, machinery and other forms of productive capacity.
2. Excessive weight and difficulty of handling, transport, and erection, and
3. Higher costs.

The first of these, the specialist labour and plant, is but a reflection of what has already been said of the craftsmanship associated with timber. The development of other materials has not been bound up with a wide-spread craftsmanship to anything like the same extent, with the result that the importation of a new material involves the importation of a new technique. The two other criticisms of weight and cost can be dealt with in mathematical terms of comparative efficiency and for this purpose it is customary to take as a criterion of merit the ratio of strength to unit weight. This ratio, which may be termed the specific strength, is only one of many criteria which can be adopted and has its greatest advanatges in the fields of mechanical and aircraft engineering where lightness of construction is of primary importance.

In ordinary building construction the position is not quite the same, lightness of construction has not the same importance and for the most part the ultimate criterion must be one of cost. The direct relationship between strength and cost is complicated by many factors, not the least important being the rapidity with which the relative costs of different materials can change through circumstances beyond the control of the designer. Because of this, it is desirable that comparisons between building materials should be made in two distinct stages, firstly by the strength—weight ratio and secondly in terms of weight and cost. For our purpose attention will be restricted to the first stage comparison, but it is important to remember that the criterion of specific strength is strictly limited in direct application. A ton of steel may cost much the same as a ton of timber to buy, transport and erect, and in such a case the criterion is directly useful ; with concrete, however, extra caution is required. No one would deny that concrete is an extremely useful material in spite of the fact that it must show up very badly if judged solely by its strength-weight ratio.

Before we can discuss specific strength in detail we must define the kind of strength we mean. This may be the tensile, compressive, or shear strength, or it may be the modulus of elasticity of the material, according to the purpose for which it is required. For ties or stocky struts, where only pure tension or pure compression is involved, the matter is simple ; all that is necessary to establish the criteria being to divide the stress by the specific gravity. It is unfortunate from the point of view of simplicity that very few structural members are subjected to pure tension or compression only, the design of the great majority of members being complicated by flexural considerations which cannot be divorced from the size and geometrical properties of the members themselves.

In attempting to take the size and geometry of a member into account it is a useful, if somewhat inaccurate conception, to imagine that all material is made of the same stuff, the variation in density between one material and another being due merely to a difference in the degree of its compactness. In *Figure 1* let us suppose that a structural member of square section A, B, C, D, is expanded or blown up to four times its original area as shown by the square A.E.F.G. If we assume that the expanded section contains the same amount of material in it as before the weight will be unaltered and the strength of the member in pure tension or compression will remain the same. This means that the specific strength in pure tension or compression is unaltered, because although the unit strength of the expanded section will be assumed to be only a quarter of the original, the density will also be reduced by the same amount.

When we consider the section in bending we see that by

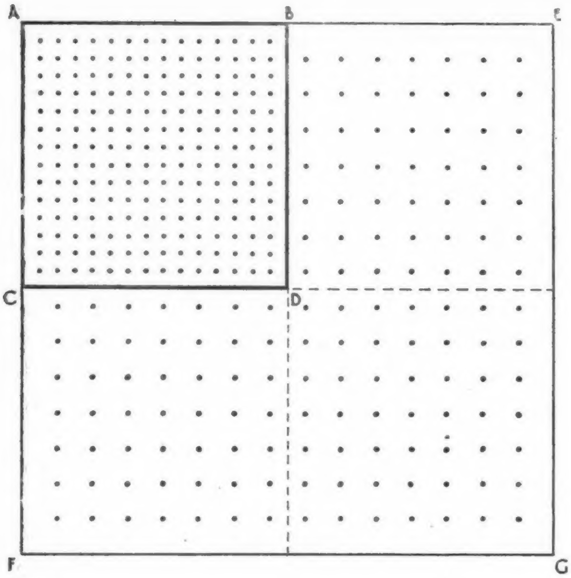


Fig. 1

increasing the area we have increased the moment of inertia also. It would be more correct to refer to it as the second moment of area rather than the moment of inertia ; it is a purely geometrical property and has nothing to do with the mass. By expanding our square section to four times its original area, we have increased the so called moment of inertia 16 times and have therefore increased the moment of resistance of the section. As the mass has remained unaltered this will give us a higher specific strength in bending. On the assumption that the permissible stress is a quarter of the original, it may be shown that the expanded section is twice as strong in bending as the original and as the weight of the member has remained constant, it follows that the specific strength of the expanded section, in bending, is twice as great as the original.

This result can be obtained by considering the problem in terms of density. For geometrically similar members of equal weight the cross sectional area varies inversely as the density. It may be shown that the section modulus varies inversely as the density raised to the power of 1.5, so that the appropriate criterion of specific strength in bending will be the stress divided, not by the density, but by this higher power of the density.

The strength of slender struts and members such as floor joists, where a limiting deflection is the governing condition, is a function of the flexural rigidity factor E.I—the product of the modulus of elasticity and the moment of inertia of the section. The moment of inertia varies inversely as the square of the density so that the appropriate specific strength criterion for this type of structural member will be E, the modulus of elasticity divided by the square of the density.

We are now in a position to make a comparison of the efficiency of different structural materials when subjected to different kinds of stress as shown in *Figure 2*. The materials selected for comparison are, in descending order of density :—

1. The metals ; mild steel and duralumin,
2. The cement products : concrete and asbestos cement,
3. The plastics : reinforced and unreinforced,
4. A plastic of the laminated wood veneer type, and
5. Timber.

Strength figures are given in appropriate columns of the table, certain figures being omitted where authoritative information is not available. The figures quoted for concrete assume a nominal 1 : 2 : 4 mix and 28 days maturity, while the particulars of asbestos cement refer to a 12 months maturity for material such as would be commonly used in corrugated sheets. In the plastics group figures are quoted for Gordon Aerolite and Nylon, the Gordon Aerolite being reinforced with linen thread, Nylon, being itself in thread-like form. The laminated veneer type plastic is a phenol form—aldehyde plywood of $\frac{1}{16}$" birch veneers. This may be considered to have as much claim to be included with the plastics as with timber, so to avoid confusion it has been put in a class by itself. Douglas fir has been selected to represent timber, the figures quoted corresponding to average values obtained from tests on small clear specimens, adjusted to allow for variability and long-continued loading on full size sections, and a moisture content of 18 per cent.

Specific strengths are tabulated in columns for Flexural Rigidity, Bending, Tension, Compression and Shear, the highest specific strength in each column being shown in a thick-bordered rectangle. It will be seen that for flexural rigidity timber is the pre-eminent material ; in bending it maintains its position if combined with plastics in the form of plywood ; in tension it is stronger than steel, weaker that duralumin, but almost insignificant by comparison with the amazing strength of Nylon. In compression the plastic bonded plywood runs a close second to duralumin, while in shear, the metals head the list with duralumin in first place and timber one of the last. Cement products attain their highest relative value in terms of flexural rigidity where they may be classed with the metals ; elsewhere their specific strength is negligible by comparison except possibly in compression and shear where asbestos cement is of the same order of strength as Douglas Fir.

If we ignore the cement products we notice that the little thick-bordered rectangles, denoting superiority of specific strength, rise from the bottom left-hand corner of the table to the top right-hand corner in increasing order of density. From this notion of a pattern a diagram may be developed which enables us to form a picture of the proper uses of materials. This is shown in *Figure 3*. In this diagram the broad shaded bands denoting metals, plastics and timber lie one above the other in order of merit according to the nature of the stress : thus, for flexural rigidity the order is timber, plastics and metals : in shear, metals, plastics and timber and so on. The materials have been shown by bands instead of lines to show roughly the effects of density ; in each band the upper limit represents the low density forms of the particular material, and the lower limit.

Specific Strength of Materials

1	2	3	4	5	6	7	8	9	10	11	12
		SPECIFIC STRENGTH									
MATERIAL	SPECIFIC GRAVITY	FLEXURAL RIGIDITY		BENDING		TENSION		COMPRESSION		SHEAR	
	g	E lbs/sq in	E / g^2	B lbs/sq in	B / $g^{1.5}$	T lbs/sq in	T / g	C lbs/sq in	C / g	S lbs/sq in	S / g
MILD STEEL	7·8	30×10^6	$0{\cdot}49\times10^6$	66,000	3,035	66,000	8,462	66,000	8,462	33,000	4,230
DURALUMIN	2·8	10×10^6	$1{\cdot}28\times10^6$	55,000	11,739	55,000	19,643	55,000	19,643	27,000	9,825
CONCRETE	2·3	$2{\cdot}5\times10^6$	$0{\cdot}47\times10^6$	700	200	400	174	4,600	2,000	400	174
ASBESTOS-CEMENT	1·6	$1{\cdot}8\times10^6$	$0{\cdot}7\times10^6$	2400	1,188	1,900	1,188	5,000	3,125	1,600	1,000
GORDON AEROLITE	1·43	$6{\cdot}0\times10^6$	$2{\cdot}93\times10^6$			45,000	31,470	24,000	16,783	5,000	3,497
NYLON	1·10					50,000	45,500				
P.F. PLY	0·95	$2{\cdot}0\times10^6$	$2{\cdot}22\times10^6$	18,000	19,440	39,000	41,000	18,000	19,000	1,590	1,670
DOUGLAS FIR	0·48	$1{\cdot}3\times10^6$	$5{\cdot}60\times10^6$	3,760	11,300	5,700	11,900	2,280	4,750	434	900

Fig. 2

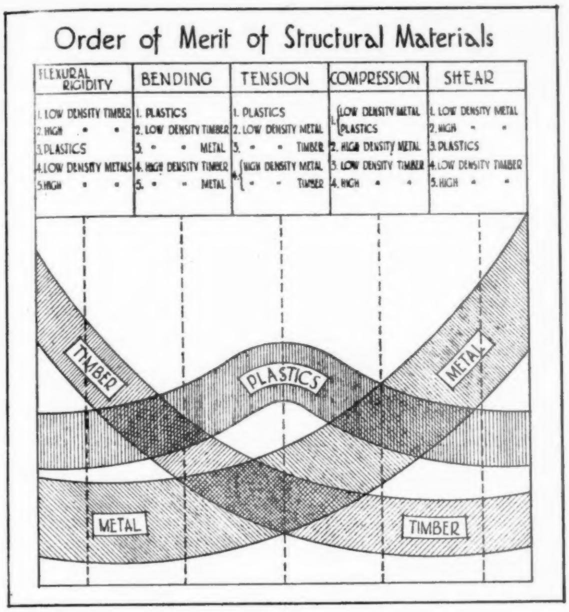


Fig. 3

high density forms. In the case of bending for instance, we find by reading down the vertical line under this heading that the materials are arranged in the following order of merit :—

1. Plastics.
2. Low density timber.
3. Low density metal.
4. High density timber.
5. High density metal.

The superior flexural rigidity of timber makes it pre-eminently the material for all structural components which can fail through elastic instability ; by buckling, bending or wrinkling rather than by the crushing of the material. Such components are slender lightly-loaded columns of solid, hollow or built-up sections ; long lightly-loaded beams ; the so called "stressed skin" construction in which the space covering or panel filling material is utilised to stiffen up the framing as in certain types of flush door, plywood covered wall and roof units, aircraft, boats, furniture and fittings and the like, and in general all components which are lightly loaded in relation to their size.

This characteristic advantage that timber has is due chiefly to the effects of expansion considered earlier ; to the higher moment of inertia developed by the lower density material when equal masses are compared. If we want to develop a larger moment of inertia with a given weight of material we do it by spreading it over as big an area as possible. This spreading or expansion can be effected in three ways :—

1. Atomically, as in the relationship between duralumin and steel.
2. Microscopically, as in wood where the cellulose is distributed in the thin walls of the cell cavities, and
3. Geometrically, as in a rolled steel joist or steel tube.

So far, for simplicity, we have restricted our comparison to members of geometrically similar section and equal weight. In the case of columns an interesting result is obtained if we compare the microscopic expansion of wood substance with a geometrical expansion of steel. *Figure 4* shows loads which can be carried by solid timber struts of circular section and rolled steel joists of equal weight. For purposes of comparison a circular timber strut of Douglas Fir 11" in diameter, and a 6" × 4½" × 20 lbs. rolled steel joist have been selected. It will be seen that for struts 4 ft. long the rolled steel joist carries 1½ times the load of timber strut ; at a length of 6′ 6″ the loads carried are equal, while with a length of 30 ft. the timber strut carries five times the load of the rolled steel joist. This is about the height that an 11" diameter fire tree would grow, so we have found at least one reason why nature grows trees instead of rolled steel joists ; nature having produced by the expansion of cellulose a far more efficient material for such slender lightly loaded columns.

In examining comparative strengths the figures quoted for timber represent ultimate stresses for loads sustained over periods of 40 or 50 years. In practice many types of loading have to be sustained for only a few minutes or even seconds, and for this type of loading timber has remarkable advantages. Tests carried out by the United States Forest Products Research Laboratory show that if we take the stresses quoted as a standard, a timber beam can sustain a load increase of nearly 30 per cent. for one month, over 50 per cent. for an hour, nearly double for 5 seconds and 2½ times as much for impact loading. In designing for wind pressure we have to consider maximum intensities which occur in gusts of only a few seconds duration, while super-imposed floor loadings of nearly all classes except warehouses have a considerable proportion of their load applied over very limited periods. If we examined the order of merit of materials for short-term loading we would find timber very high up the list indeed, with particular advantage for the construction of roofs, towers, pylons, high single-storey shed buildings of the hangar type, and all floors carrying a large proportion of intermittent loading.

As it is, our comparative analysis has shown us that timber has a very high order of efficiency, much higher than would be supposed if judged solely by the attention paid to it in modern structural engineering. On the other hand, the analysis provides us with a striking confirmation of the correct uses to which the craftsman has put timber, with one notable exception ; if we examine a typical 19th century roof truss or trussed girder we find that the members are not only far too big, but that short compression members are made of timber, while the tension members are of steel. In contradiction our comparative analysis tells us that timber is the correct tension material and steel more efficient in pure compression. If we look for the reason for this apparent anomaly, we find that it is briefly, knots and joints ; knots which may completely ruin the strength of a tension

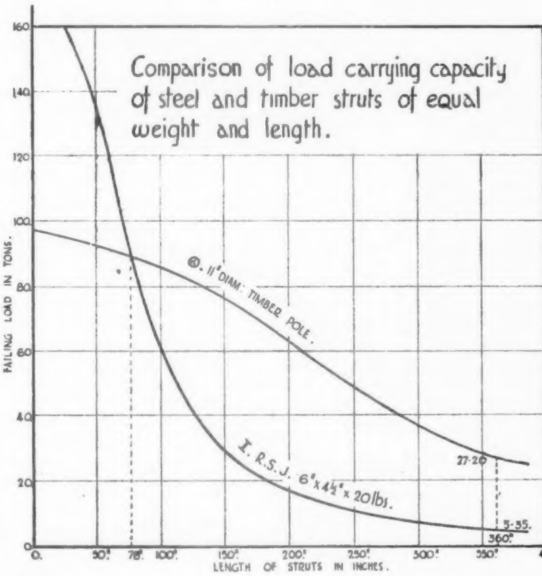


Fig. 4

member, and joints which can only be made by cutting away a substantial part of the cross section.

If these inherent disadvantages could be overcome science would have placed in the hands of architects and engineers a structural material of outstanding value even by comparison with the most up-to-date products of industrial ingenuity, and science is in a fair way to do it. The solution of this particular problem is to be found in stress-grading and modern adhesives; stress grading which gives us quality control of timber, and adhesives which make lamination possible and provide us with highly efficient joints.

Stress Gradings

The value of stress grading arises out of the relationship existing between the strength of a timber and its visible defects. If we take a large number of standard test pieces and sort out one batch in which the largest knots occurring in a specified length occupying say 15 per cent. of the width of the piece, and another batch in which the knots occupying say 30 per cent. of the width, we would find the average strength of the first batch significantly higher than the second. This percentage or knot ratio when considered in relation to other types of defect ;- shakes, checks, spiral grain and so on, provides a reliable and simple criterion by which to gauge the structural properties of the material. It is essentially a matter of statistics and probably one of the most important single contributions that mathematics can make to modern timber mechanics. Valuable work on these lines has been carried out by the Forest Products Research Laboratory at Princes Risborough, and the first British Standard on Grading Rules for Structural Timber was issued in 1941, but the subject is still new and there is still much to be done to make stress grading really effective.

The adoption of a rational stress grading system puts a quantitative value to qualitative judgment, and thereby makes the use of refined design methods an economical alternative to the empirical approach of the craftsman.

The method adopted in fixing permissible stresses for selected knot ratios follows the normal statistical procedure which has now become more familiar to industry under the name of "quality control." If a large number of similar pieces of timber with the same knot ratio and the same visible defects are tested for say, crushing strength, it would be found that the test results would still cover a very wide range, varying from a minimum of perhaps 3,000 lbs. per square inch to a maximum in the region of 8,000 lbs. per square inch. If we adopted as the basic stress the lowest test result ever recorded it is obvious that we should involve a tremendous waste of timber in catering for a defective sample which might occur as a chance of one in a million. In the interests of economy, therefore, we have to adopt a working stress related to the chance of individual failure which we are prepared to accept.

The large variations in test results may be due to a member of unidentifiable causes and we will assume that they cannot be reduced by any greater stringency of classification. Now it can be shown theoretically and experimentally that when a large number of independent causes operate by chance to introduce variations of this nature, the varying results will be distributed around their mean value in a definite and characteristic way. Let us suppose we test a random sample of 100 pieces of the same quality timber and then sort out the results in groups varying between the same stress limits; we might expect to find one piece failing between 3,000 and 3,200 lbs. per square inch, another between 3,200 and 3,400 lbs. per square inch, perhaps two pieces between 3,400 and 3,600 lbs. per square inch, and so on. We could then plot these numbers on a diagram which would show the frequency with which results fall within the predetermined limits. Such a diagram is shown on *Figure 5*. This sort of frequency distribution is called "Normal" or "Caussian" and it has the property of being wholly defined by calculations we can make from the test results of our sample. The important point is that from the characteristics of the sample

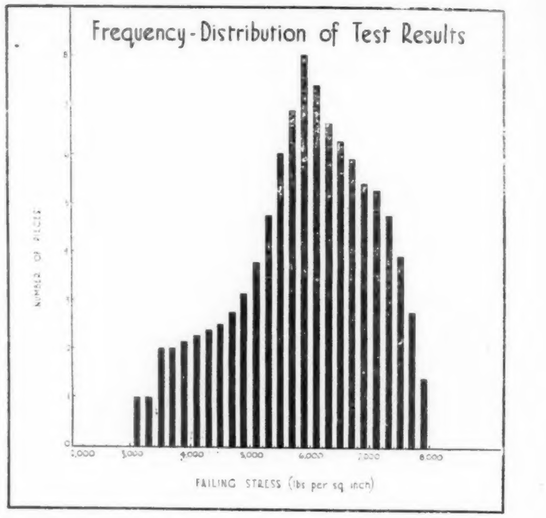


Fig. 5

we can predict the characteristics of the bulk and are then in a position to fix upon a stress below which no more than an agreed percentage of specimens shall fail. The greater the number of rejects we can accept the higher will be the working stress. The number of failures or rejects we accept must of course be governed by the degree of testing employed on the finished article. In aircraft construction where testing is carried out to a very high degree, a large percentage of rejects is accepted with the result that very high working stresses are possible. In ordinary building construction with no rigorous testing system the percentage must be small and working stresses are consequently lower.

Lamination

If out of our imaginary 100 test pieces we had taken one at random to build into some structure, this piece might conceivably have been the poorest specimen of them all; if so we should be relying on our factor of safety to see us through, for our working stresses have been fixed with the full knowledge of just this possibility. Suppose, however, that instead of taking one piece we had taken two and glued them together. This second piece could not possibly be the lowest, it must necessarily be somewhat stronger, so that the combined strength of both members must be more than twice the strength of the poorest specimen to which our working stresses are related. To carry the picture a stage further let us now suppose that we glue the whole of our 100 test pieces together side by side. The poorest specimen was assessed at 3,000 lbs. per square inch, the best at 8,000 lbs. per square inch; if our structure is such that the poorest specimen cannot fail without involving the failure of the best, the strength of the composite member will be the average strength of all its parts. Now if we assume that the average strength is say 6,000 lbs. per square inch, we see that by gluing them together we have brought about more than a slight increase in permissible stress, we have doubled it if we based our working stress on the 3,000 lb. specimen. This, together with the elimination of framing joints constitutes the outstanding advantage of laminated structures. Working stresses are necessarily based on the strength of single units; when two or more are joined together we justify an increased stress. Statistical analysis tells us what increases we can make; we find that for two members we can increase the stress by about 33 per cent. for three 50 per cent., and so on, all pointing the way to more economical timber structures than we have yet known.

Lamination gives us plywood and makes possible the construction of large span beams and arches which, being in a single

large cross section, involve no intricate framing, lend themselves more readily to architectural treatment and have far better fire resistance than the equivalent truss composed of smaller pieces. Although in one composite piece, they can be built up from material too small to be otherwise useful and can utilise poor quality materials in the lightly stressed parts. Beams can be cambered to avoid the undesirable appearance resulting from obvious sagging and all members can be tapered in depth for more graceful appearance and to save material where constant depth contributes but little to strength and stiffness.

Adhesion and Adhesives

In 1721, Isaac Newton observed that there were "agents in nature able to make the particles of bodies stick together by very strong attractions" and he concluded it was "the business of experimental philosophy to find them out." 200 years went by, however, before experimental philosophy made any comprehensive study of the subject, and we still await the complete theory of the nature and laws of adhesion which will secure universal acceptance.

The general conclusion is that adhesion between two solid bodies may be of two kinds: specific adhesion produced by molecular forces of the same kind as hold together the molecules of a solid body, and mechanical adhesion obtained by the keying of the solidified adhesive into the crevices of the materials joined. Mechanical adhesion needs little explanation; the interpenetration of adhesives with wood fibres is readily understood, but its relative importance or even desirability is not established beyond all doubt.

For one of the most interesting explanations of specific adhesion we are indebted to Dr. de Bruyne of Aero Research Ltd. He distinguishes between the primary chemical bonds which tie molecules together like links in a chain, and the secondary bonds which hold these chains to each other. These secondary bonds are of electrical origin and are described as "polar" or "non-polar," according to their characteristics. It is these secondary forces which are of importance to the designer. Failure of materials occur through their disruption, and it is their power of attracting or holding molecules of other materials which make specific adhesion possible.

Polar forces are usually much stronger than non-polar, with the result that their molecules will not mix, the forces of attraction between the polar molecules being strong enough to squeeze the non-polar out. This happens when we try to mix polar water with non-polar oil. Conversely, birds of a feather flock together, and, according to de Bruyne, any polar material which can be applied to wood in a liquid state and then solidified will make an effective glue, wood itself being held together by forces of a polar nature. On this basis, we would expect water to make an excellent glue for wood, as indeed it does; joints displaying apparent shear strengths of the order of 1,000 lbs. per square inch having been obtained by simply freezing two pieces of wood together.

The shear strength of a glued joint cannot be regarded in the same light as say, the shear strength of a rivet, as the strength of the glue may not itself be the governing factor. If the glue were weaker than the timber, the strength of the glue film would be of major importance but with modern adhesive this is not generally the case, these adhesives usually having a shear strength much greater than the shear strength of wood. In these circumstances we find that the strength of the joint is governed by the thickness and physical properties of the materials joined as well as by the shape of the joint.

Tests on simple lap joints carried out at the Royal Aircraft Establishment indicate that :—

1. The failing load is proportional to the width of the joint.
2. The failing load increases with increased thickness of the members joined, and
3. The failing load is not proportional to the length of the overlap.

This means that we cannot quote a permissible stress for glued joints without reference to the dimensions and species of the timber. To meet this difficulty de Bruyne has suggested the employment of a "joint factor" to relate the geometry of the joint to its failing stress for any given species of timber. The joint factor suggested is equal to the square root of the thickness of the member divided by the length of the overlap. The relationship between this factor and the strength of joints made with Aerolite glue is shown on *Figure 6* for birch, beech and spruce, the curves indicating maximum shear values of the order of 2,000 to 2,500 lbs. per square inch. It will be found that the mean permissible shear stress decreases as the length of the overlap is made larger and if we consider practical joints in spruce we find there is little theoretical advantage to be gained in making the length of the overlap more than about 4 times the thickness of the material.

In the tests made at the Royal Aircraft Establishment a number of test pieces were cut out of solid timber in the same form and shape as the glued specimens. These were tested in the same way to examine the effect of changes in the length of overlap. The result of the tests on beech and spruce translated in terms of the joint factor, are shown by dotted lines on *PLATE 6*. The

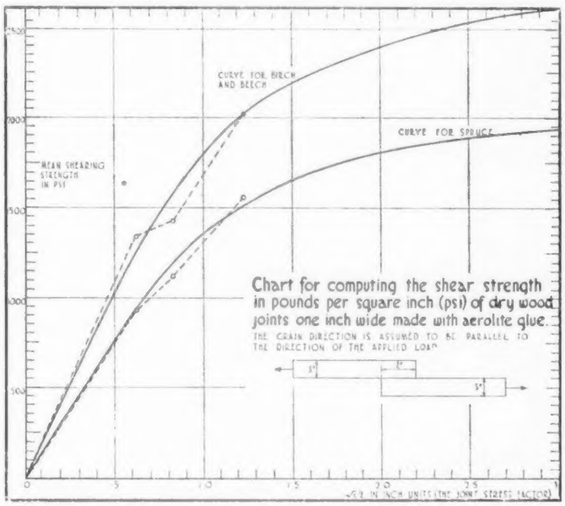


Fig. 6

excellent agreement with the strength of Aerolite glue joints will be noted, in icating as already suggested, that the failure of a joint glued with an adhesive of optimum strength is essentially a wood failure and not a glue failure.

Gelatine glues of good quality could always be produced which were stronger than the wood they joined, so it has not been necessary for modern research to find a stronger glue so much as a stable glue; a glue which could easily be applied and which would have a greater resistance to the effects of humidity and the normal processes of decay.

Gluing does for timber what welding does for steel; it enables joints to be made without cutting any material out of the members joined and makes it possible for the designer to take advantage of all the economics associated with monolithic construction. A glue which will not lose its strength when wet, which is not subject to the ravages of micro-organisms, which will not crack or craze through its own internal stresses, which will maintain its efficiency over a wide range of temperatures and have a permanence comparable with that of wood itself, will revolutionise timber construction and give almost unlimited scope and freedom of architectural expression.

Synthetic and casein plastics have produced adhesives which have many of these desirable qualities but experience has yet to

confirm that any one product combines them all. Casein, the product of skimmed milk, was widely used before the war. It is cheap and easy to apply, and in dry situations it has a long working life. It loses strength when wet, however, and under certain conditions of temperature and humidity it is subject to the growth of micro-organisms.

The synthetic re ins now commonly used are plastics made available through the inter-action of either phenol or urea with formaldehyde. Both the phenol and urea formalehyde adhesives can be highly water-resistant, they can stand high temperatures without loss of strength and are not subject to bacterial attack. They require stricter control in application than casein and on the whole are more liable to crazing. Tests carried out by the United States Forest Products Research Laboratory indicate that phenol formaldehyde adhesives have retained a high percentage of their strength after four years exposure under the most exacting conditions; conditions which could never occur in actual practice and which must be regarded as equivalent to a very long working life. In America a lot of attention has also been paid to glues manufactured from blood albumen. These also have been tested and while they appear to be much superior to casein, they do not appear to have retained their strength when wet to the same extent as phenol formaldehyde. In other respects they compare quite favourably, but they do not seem to have been used to any great extent in this country.

One of the most significant developments in plastic adhesives is known as the "Redux" process, particulars of which have recently been released by permission of the Ministry of Aircraft Production. It is claimed for the process that through the use of a synthetic resin it enables light alloys and steel to be cemented together or to wood, giving joints stronger than comparable riveted joints. It is mildly thermo-plastic and loses strength at temperatures of about 212° Fahrenheit which is regained on subsequent cooling. It is stated that this loss of strength does not render the process unsuitable for aircraft work. Such a process seems to bring us within measurable distance of the composite structure in which wood, metals and plastics can play their proper parts welded together with joints of 100 per cent. efficiency.

Mechanical Joints

The United States Forest Products Research Laboratory has devoted considerable attention to the strength of mechanical joints made with nails, screws, bolts and surface dowels. *Figure* 7 shows a simple double lap joint between tension members connected by a rigid bar. The shaded area in Figure 7.1 indicates the approximate stress distribution along the length of the bar and it will be seen that the maximum bearing stresses occur at the interfacial surfaces A.A. and B.B. From this is will be evident that although we have weakened the members of drilling through the whole of their thickness, the bar is only doing useful work at the interfaces. Hence we derive the principle of the surface dowel shown in Figure 7.2. Here we get the maximum effective bearing surface combined with the minimum depletion of the cross section. In this country we have had little opportunity of building large timber structures during the war, but, judging by the progress made in America the surface dowel type connector is likely to prove one of the most important developments in timber engineering.

Figure 7.3 shows the type of failure which may occur through shearing along the lines C.C. and D.D. It is obvious that increasing the diameter of the bar will not help as the shearing planes will remain of the same dimensions. In these circumstances a small diameter bar will be as strong as a large one, and, as will be apparent from Figure 7.4 the joint is made stronger by the use of a larger number of smaller bars. This illustrates the special virtues of nails and screws and in Germany in particular a great deal of attention has been paid to the structural use of nailed joints. Generally, shearing failures of this type only occur at the ends of tension members and may be avoided by extending the distance X shown on figure 7.5. This is not

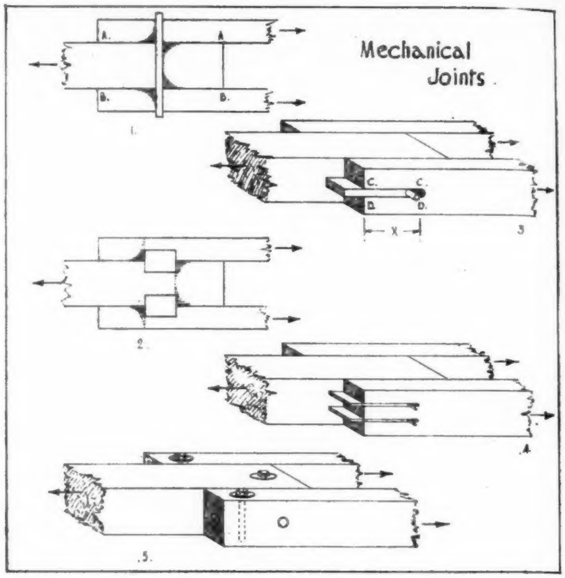


Fig. 7

always practicable, but as an expedient the stitch bolt shown in figure 7.5 is sometimes employed successfully.

In the design of any type of mechanical joint it is necessary to give the same consideration to the spacing of the connectors as is customary in designing a riveted connection in steelwork. The rules are necessarily more complicated as they have to deal, not only with the distances between the connectors and the ends and sides of the members and distances between each other, but must also take into account the species of timber, direction of grain, moisture content and type of connector used. The rules of design are too varied and complicated to be considered here in detail but an idea of the relative strengths of different types of connector can be obtained by comparing the members required to provide the same bearing strength in a simple double lap joint such as that shown in *Figure* 7. Assuming that Douglas Fir is used with a minimum thickness of 2", it may be shown that equal bearing strength is provided by :—

2—2½ in. bolted split-ring connectors,
8—2½ in. bolted hardwood dowels,
10—½ in. diameter bolts,
18—¼ in. diameter wood screws, and
26—⅛ in. diameter wire nails.

This comparison illustrates the superiority of the split ring connector shown on the upper part of *Figure 8*. It consists of a split circular band of steel embedded in prepared grooves so that half its width is in one member and half in the other, the assembly being held together by a connecting bolt. The split in the ring enables it to open slightly under load so that both the inside and outside bear against the wood and transmit the load over the area shown shaded in the lower part of *Figure 8*. This is a much greater distribution area than can be obtained with an ordinary bolt and increases the strength of the joint in a marked degree.

Split rings of this type are commonly made in diameters of 2½", 4" and 6" and carry loads of from 1 to 5 tons according to the timber and the diameter of the ring. Split rings cannot be used efficiently in members less than 4" deep; a minimum thickness of 1" is required where rings are used on one face only; 2" if on both faces.

Although the split ring is probably the type of connector most commonly employed in America, the types available are many and varied.

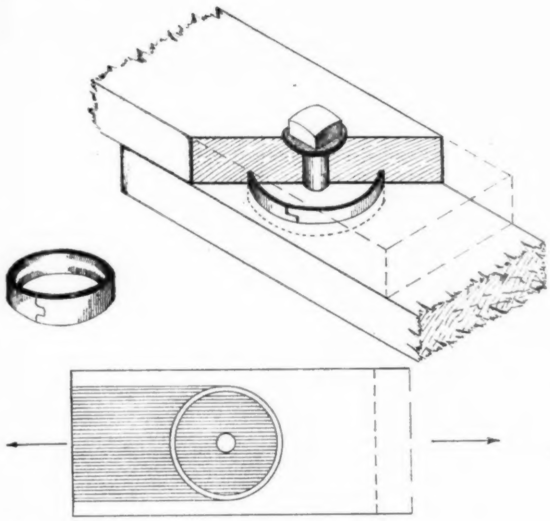


Fig. 8

Built-up Construction

The combined use of lamination, adhesives and metal connectors in a single structure is a recent American development, indicating the current trend in timber engineering. A noteworthy example is shown on the upper part of *Figure 9* which illustrates a heavy girder with laminated flanges and solid stiffness, covered with plywood webs, the whole assembly forming a box girder. The construction is somewhat unusual in that the laminations are held together with toothed metal connectors instead of glue. The resin-bonded plywood webs are nailed to the flanges and stiffeners, with cement coated nails and the whole girder is carried on posts by timber connectors.

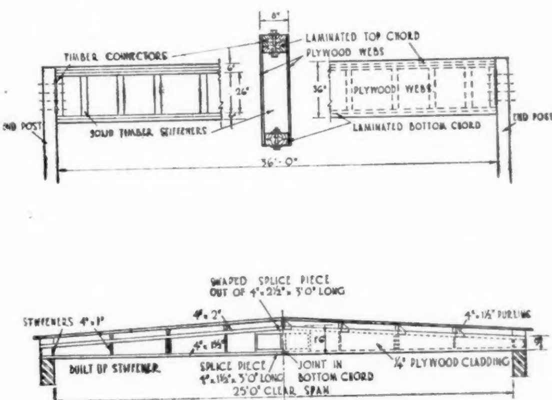
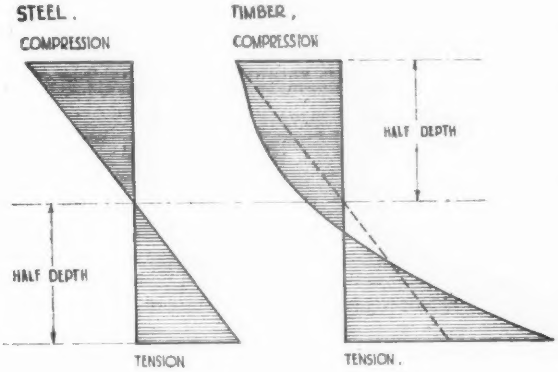


Fig. 9

The lower part of *Figure 9* shows a nailed and glued plywood box girder designed by the Ministry of Works. In this case, nailing is only used to provide the necessary pressure for the adhesion of the synthetic glue.

The use of plywood for the construction of beams and girders is a very economical but comparatively new development, and one which holds great promise particularly in the field of prefabrication. It must not be overlooked, however, that the building up of hollow timber beams or girders of joist section requires greater refinement in design method than is necessary for solid rectangular sections. Unlike steel timber has different ultimate strengths in compression and tension and it behaves in a different way in bending. Owing to its well defined grain timber distributes its bending stresses in a different way from steel and the built-up timber beam or girder emphasises in the



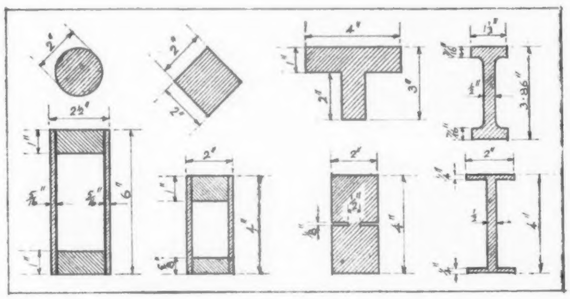


Fig. 10

highest degree the different behaviour of the two materials. The difficulty of determining the actual stress distribution which really occurs arises from the fact that we have no direct means of measuring stress in a beam. We can measure things like weight and distances and we can measure strain and deflections, but stress always remains a matter of calculation. Of these calculated stresses the "modulus of rupture" is probably the most used in design. The modulus of rupture is the calculated bending stress at which a tested beam fails and this calculation is made on the assumption that timber bends in the same way as steel. It does not correspond with any of the fundamental properties of wood and is a purely hypothetical value. In the circumstances it is not surprising if this calculation sometimes gives puzzling results; for instance, if two rectangular beams, one shallow and one deep, of the same characteristics and quality are tested under identical conditions, the shallow beam exhibits a higher modulus of rupture than the deep one. This is due to the fact that the assumptions behind the ordinary beam formula do not fit the type of stress distribution which occurs in timber.

In our comparative analysis of specific strengths a stress of 2,280 lbs. per square inch was used for compression. As this is much lower than the tension stress, the ordinary assumptions of design should lead us to use it for bending, for evidently the

beam ought to fail on the compression side when this stress is reached. So far from this being the case, we find we can work to a hypothetical modulus of rupture which is about 65 per cent. greater.

On *Figure 10*, figure 10.1 we have the standard case of the straight line distribution assumed by the ordinary beam theory with maximum compression and tension equal and a linear variation through zero at a neutral axis situated at mid-depth. The internal work done in straining is related to the area shown shaded, and it will be seen that the work done in compression is equal to that done in tension. In figure 11.2 we have the sort of strain distribution which actually occurs in timber. This distribution has been confirmed by Albert Diets of Massachusetts Institute of Technology, who has shown by the use of electrical strain gauges that under stress the neutral axis of a solid timber beam moves in a marked manner towards the tension side and that the rate of increase of strain does not conform with the straight-line theory. The shaded areas are still equal, but now we have a maximum intensity of tension much greater than the maximum intensity of compression. The bulge in the compression area explains why we get a modulus of rupture higher than the ultimate compressive stress ; it shows that work is being done down in the body of the beam which is not allowed for by the ordinary theory, but we still have no explanation why the bulge occurs. How is it, in fact, that well down in the body of the beam strains occur almost as great as the strain in the outermost fibre ?

An interesting explanation come from Newlin and Trayer, at the United States Forest Products Research Laboratory. They argue that the slender, hollow tapering cells comprising the great mass of wood tissue act in compression somewhat like small slender columns. When a beam is loaded, the tiny columns on the outermost compression side are restrained against buckling by their neighbours below. When they receive their maximum load they deflect slightly and allow these neighbours to take up some of the strain. These fibres in turn rely on their lower neighbours, and when fully loaded pass on some of the burden and by this means a stress approximating to the maximum is redistributed down into the body of the beam.

If such a section is fully stressed over the whole area as might occur in a short column all the fibres will receive an equal load and there will be no lightly stressed fibres to help the overworked brethren and consequently the strut fails at a lower stress than the beam.

If our beam is made hollow like a box a similar condition applies, there are now no fibres in the middle to help the highly stressed area on the outside and again we find that the box girder fails at a lower stress than the solid beam.

This does not mean that the solid beam is more economical, but that in designing box beams or beams of joist section we have to take this phenomenon into account. This could be done by using a correct theory of flexure, but unfortunately, the correct theory which agrees entirely with observed results has not yet been developed. In the circumstances our only alternative is to employ the ordinary beam theory and modify the results by the use of factors determined experimentally. Tables of these factors called " form factors," have been compiled by the United States Forest Products Research Laboratory. They have been derived from tests on beams covering a large range of shapes and dimensions and experience has confirmed that they can be used successfully for extreme section of the type shown in figure 11.3.

Conclusion

Before attempting to summarise it should be made clear that the ground covered has been deliberately restricted to those aspects of timber engineering which are considered to have shown the most significant development in recent years. No reference has been made to the effects of rate of growth, moisture content and moisture equilibrium, seasoning, preservation and fire resistant treatments or to the question of insulation. Any partial representation of this kind is in danger of giving a distorted picture of the whole and it cannot be over-emphasised that there are many other aspects of timber engineering which are of the utmost importance to the designer even though they may not have much to show in the way of recent development.

Turning to the aspects we have examined, we find first of all that timber has a very high comparative efficiency in terms of the strength-weight ratio. Except under shear, we find that timber compares very favourably indeed with other materials and is pre-eminent in the range of structures which are large in relation to the loads they sustain or which are subjected to temporary or intermittent loading. We have sounded a warning note on the exclusive use of the strength-weight ratio and pointed out that it is not the only criterion but should be regarded as a step towards the ultimate criterion of cost.

The developments we have considered as being significant to the trend of modern design are :—

1. The application of statistical methods to the stress-grading of timber.
2. The utilisation of statistical results to provide high working stresses for laminated forms of construction.
3. The development of stable and water resisting adhesives for the purposes of lamination and to provide highly efficient joints.
4. The use of mechanical timber connectors as an alternative to adhesives.
5. The use of plywood in built-up structural components with particular reference to their application to pre-fabricated methods of construction, and finally
6. The development of scientific research into the anisotropic behaviour of wood, the characteristic behaviour of a material with a well defined grain.

Scientific research is seen as the key to all these developments and may well bring about a renaissance of timber as a material for scientific construction.

References

1. Aero Research Technical Notes, Bulletins April and August, 1943.
2. " Adhesion and Adhesives," Butterworth, " Chemistry and Industry," August, 1942.
3. " Conservation of Wood," Dietz, Boston Society of Civil Engineers.
4. " Controlled Exposure Tests on Water Resistant Glue Joints," Brouse, United States Department of Agriculture.
5. " Designing Timber Connector Structures," Timber Engineering Co.
6. Final Report of the Adhesives Research Committee, H.M.S.O.
7. " Form Factors of Beams subjected to Transverse Loading," Report No. 181, United States Department of Agriculture.
8. " Grading Rules for Structural Timber," B.S. 940, Part I, 1941, Part II, 1942.
9. " Grading Softwoods for Strength," Leaflet No. 19, Forest Products Research Laboratory.
10. " Manual of Timber Connector Construction," Timber Engineering Co.
11. " Mechanical Physics," Dingle, Thos. Nelson.
12. " Plastics," Yarsley & Couzens, Penguin Books.
13. " Plastics in Structural Engineering," Dudley, " Plastics," September, 1943.
14. " Plastics Progress," de Bruyne, " Flight," January, 1939.
15. " Quality Control," B.S. 1008 ; 1942, British Standards Institution.
16. " Quality Control Charts," Dudding & Jennett, B.S. 600 R. 1942.
17. " Solid Organic Materials used in Engineering," de Bruyne, " Aircraft Engineering," May, June, July and August, 1943.
18. " Stress-Strain Relations in Timber Beams, Dietz, A.S.T.M. Bulletin, October, 1942.
19. " Stressed-skin Wooden Construction," Stepniewski, " Aircraft Engineering," April and May, 1943.
20. " Sub-atomic Physics," Dingle, Thos. Nelson.
21. " The Glued Laminated Wooden Arch," Tech. Bulletin 691, United States Department of Agriculture.
22. Wood Handbook, United States Department of Agriculture.

BOOKS

"Grig in Retirement" by H. B. Creswell. 8-vo. 1943. Faber and Faber. 9s. 6d.

Everyone who has read Mr. H. B. Creswell's earlier book *Grig* will be glad that Mr. Grigblay, builder, has recovered from his illness and has again been compiling his 'journal.' Those who have not already made the acquaintance of this redoubtable character should repair the omission without delay.

Mr. Grigblay is now nominally in retirement, but continues, in fact, to take a most active part in his building and contracting business. He lives in a house adjoining the firm's office and workshops and nothing that occurs escapes his notice and active intervention.

"Grig" was always the Master, but in his old age he has become a little more domineering and a little more cocksure that he knows a bit better than anyone else how to deal with men and affairs. But in spite of this, his humour, and his delightful way of expressing his judgments, his love of good work and of those who serve him well, make him as attractive as ever.

In this volume Mr. Grigblay comes into contact with a new sort of people and he also becomes a local Councillor. This gives him ample opportunity of expressing his contempt, in his own downright way, for those whether they be professional men, builders, or members of the Council, who do not know their job, or who have acquired a smattering of knowledge from books rather than from practical experience.

The architects, engineers and quantity surveyors are not always very convincing, but they lend themselves to Grig's racy description. The tale of his efforts to save a youthful firm of architects, husband and wife, both fresh from an architectural school, from bad mistakes of inexperience, are diverting.

The vagaries of women and their love affairs also entangle themselves with the bricks and mortar. Grig, because of his admiration for a young woman, is led into acting the part of architect as well as builder. He employs a "ghost" embodied in an irrepressible young Irishman, who in the end defeats Grig and carries off the lady.

Mr. Creswell never loses his sure touch in drawing "Grig," who is no literary figure but real flesh and blood. For this reason the lay reader will enjoy the book as much as those with a knowledge of the trade. Mr. Creswell adds a short glossary to explain the technicalities, which must inevitably occur in Grig's journal, which deals so faithfully with building matters.

OSWALD P. MILNE [*F.*]

Accessions to the Library

1943-44—II *(continued)*

Owing to the urgent need to economise space this list now records only new publications, excepting old publications having reference to current demands, e.g. on planning and topography. The others are summarised at end under "Older Works."

For economy of space the following also are now generally excluded from the list: (1) Year-books, lists of members, &c.; (2) extracts from periodicals, and reprints from periodicals which, being in the library, are noted in the REVIEW OF PERIODICALS; *(3) Government leaflets of slight or transitory interest. Full particulars are always available in the library.*

Books presented by the publishers for review marked R.
Books purchased marked P.
**Books of which there is at least one copy in the Loan Library.*

BUILDING TYPES *(concluded)*

DOMESTIC

BRITISH BROADCASTING CORPORATION
Science at your service, *broadcast series*:—
Inf. file 728 : 696/699 : 5/6
i. HUXLEY (JULIAN S.) : Science and the house. (Oct. 1.)
728 : 696.6
dupl. Inf. file, ditto

BRITISH ELECTRICAL DEVELOPMENT ASSOCIATION
*The Design and electrical equipment of houses and flats. Evidence submitted *&c.*
pam. 13″. n.p. [1943.] R. (4).

HALTON (ELIZABETH A.) 728.1 + 711
Houses, towns and countryside. (Town and Country Planning Association.)
Revised ed. of ASSOCIATION FOR EDUCATION IN CITIZENSHIP *and* GARDEN CITIES AND TOWN PLANNING ASSOCIATION's work, 1939.
pam. 7¾″. Lond. 1943. 1s.
Presented by the Author.
Original work, 1939, already in Library.

INSTITUTE OF HOUSING, *Birmingham* 728.1 (063) (058)
Annual conference. 1943. . . . Report of proceedings.
pam. 9½″. Birmingham. [1943.] 2s. 6d. R.
Inf. file 728.1 (42)

NATIONAL FEDERATION OF BUILDING TRADES OPERATIVES
Plan housing now!
pam. 8″. Albury. [1943.] 6d. R.
71 : 3 file
728.1 [72.08 : 336.211 : 352

OXFORD : NUFFIELD COLLEGE : SOCIAL RECONSTRUCTION SURVEY
Memoranda:
Mem. 40. The Incidence of rates on houses. By M. P. Fogarty. (*From* Review of Economic Studies, summer number 1943.)
pam. 9½″. n.p. [1943.] R.
With slip on front, adapting as Mem. 40.

MINISTRY OF HEALTH Inf. file 728.1 : 728:68 (42)
Housing (Rural Workers) Acts, 1926-1942. (Circular No. 2877.) [Works not costing more than £250 a house.]
leaflet. dupl. typescript. 7″. 1943. R.
Inf. file 728.1 : 940.5344 (063) + 728.86 : 69.071:6

JOINT CONFERENCE OF THE R.I.B.A., NATIONAL HOUSE-BUILDERS' REGISTRATION COUNCIL, *and* BUILDING SOCIETIES' ASSOCIATION
Post-war housing. Report *&c.*
dupl. typescript. 13″. (Building Societies' Assn., 14 Park St., W.1.) 1944. R.

R.I.B.A. Inf. file 728.67 : 940.5344
[Farm buildings.] Ministry of Agriculture and Fisheries Farm Buildings Committee. . . . William Keay . . . and . . . H. Duncan Hendry . . . memorandum *&c.*
dupl. typescript. 13″. [1943.]
728.86 : 69.071.5] 608.375

NATIONAL HOUSE-BUILDERS REGISTRATION COUNCIL
A Comparison of the original clauses of the model specification and the proposed modifications thereof recommended for the approval of the . . . Council.
pam. 12¾″. Lond. [19—.] *Presented.*

[ASCOT GAS WATER HEATERS *Ltd.*] 728.933.1
*Kitchen planning. Outline of findings and suggestions for further investigation.
2nd ed. dupl. typescript. 13½″. 1943. R. (3).

KITCHEN PLANNING CENTRE (LEVER BROS. & UNILEVER, *Ltd.*), *London*
728.933.1 : 729.9
*Recommendations for a standardised form of kitchen storage. A report on post-war kitchen planning *&c.*
pam. 13″. Lond. [1943.] R. (2).
728.933.2 + 728.933.1 : 648.2
*A Survey of kitchen sinks and washing facilities.
pam. 13″. Lond. [1943.] R. (2).
Details of recommended sink unit, *leaflet, inserted.*

DETAILS

GIEDION (SIGFRIED) 729.381.91 : 683.335.32
A Complicated craft is mechanized. Development of the pin-tumbler cylinder lock *&c.* (*From* Technology Review, xlvi, 1, Nov.)
pam. 12″. Cambridge, Mass. [1943.]
Presented by the Author.

VSESOIUZNAYA AKADEMIYA ARKHITEKTURY : KABINET STROITEL'NOI TEKHNIKI
729.386.45
Arkhitektura i konstruktsiya irkerov [architecture and construction of bay windows]. By M. S. Tupolev and Iu. S. Rubinstein. A. V. Kuznetsova, *ed.*
9¾″. 110 pp. Moscow : Izdatel'stvo Vsesoiuznoi *&c.* 1938.
729.393.1
Arkhitektura i konstruktsiya balkonov [balconies]. By Z. S. Chernisheva, M. S. Tupolev, and Iu. S. Rubinstein. A. V. Kuznetsova, ed.
10″. 204 pp. Moscow : Izdatel'stvo Vsesoiuznoi *&c.* 1938.
— Transferred as gifts from library of the Society for Cultural Relations with the U.S.S.R.

ALLIED ARTS

Inf. file 7] 37
COMMITTEE ON EDUCATION IN APPRECIATION OF PHYSICAL ENVIRONMENT (*afterwards* COUNCIL FOR *&c.*)
The Future citizen and his surroundings. (Evidence to Sir Cyril

Norwood's [Board of Education: Secondary Schools Examinations Council:] Committee on Curriculum and Examinations in Secondary Schools.)
pam. 8½". Lond. [1943.] 3d. R.
with C.E.A.P.E. leaflets

WILLCOCKS (C. BIRDWOOD) 7] 37
Council for Education in Appreciation of Physical Environment. [Article.] (*From* Town and Country Planning, Autumn.)
[Reprint by Council . . .] leaflet. 8¼". [Lond. 1943.]
Presented by the Council.
Inf. file 7] 37

COUNCIL FOR EDUCATION IN APPRECIATION OF PHYSICAL ENVIRONMENT, *formerly* COMMITTEE ON &c.
Book list . . . Additional books [to R.I.B.A. list].
7] 37 : 791.45
dupl. under this
Film list &c.
Origin and aims &c. [Including] Syllabus . . . for teachers.
School exhibitions.
4 pams. each 7¼". Lond. [1943.]
[Letter, &c.] 2 leaflets. var. sizes. [1943.]
—*All presented by the Council.*

EMBRU, *firm, Rüti, Zürich* Inf. file 749 : 712 (085)
Gartenmöbel.
pam. 8¼". Rüti. [1943.]
Enclosed in Werk *journal, April.*
749.034 (47)

AKADEMIYA ARKHITEKTURY S.S.S.R.: KABINET VNUTRENNEGO OBORUDOVANIYA [Interior Equipment Section]
Obmery mebeli [sizes? of furniture].
Vypusk i. Obraztsy mebeli russkoi raboty kontsa xviii—nachala xix beka [examples of Russian-made furniture from the end of the 18th to the start of the 19th century]. N. N. Sobolev, ed. (Al'bom obmerov, *cover series title.*)
10¼". 159 pp. Moscow. 1940.
Presented through the U.S.S.R. Society for Cultural Relations with Foreign Countries.

BUILDING

BRITISH STANDARDS INSTITUTION 69 (083.74)
Handbook of British standards 1943. (B S Handbook No. 1, 1943. *cover title.*)
8½". Lond. [1943.] 1s. 6d. R.
69 : 37

BUILDING APPRENTICESHIP AND TRAINING COUNCIL (MINISTRY OF WORKS)
Report: First. (Dec. 1943.)
pam. 9¾". Lond.: H.M.S.O. 1944. 6d. R.

BRITISH BROADCASTING CORPORATION
Science at your service, *broadcast series*:—
Inf. file 69 : 5/6
[Unnumbd.] APPLETON (*Sir* EDWARD) and BURT (*Sir* GEORGE): The Science of building. (Oct. 8.)
2 dupl. typescripts. 13". 1943. *Presented by the B.B.C.*

STRUCTURAL MECHANICS

ABBOTT (P.) 69.04 : 531
*Teach yourself mechanics. (The . . . Teach yourself books.)
7". 271 (incl. xii) pp. Lond.: English Univs. Press. 1941. 2s. 6d. R. *To Loan Library.*

BUILDING APPARATUS

BRITISH STANDARDS INSTITUTION 69 (083.74)
69.057.6 : 693.54
War emergency B.s. 1139. Tubular steel scaffolding.
1943. 2s. R.

BUILDING PRACTICE AND INDUSTRY

BUILDING INDUSTRIES NATIONAL COUNCIL 69.08 (063)
*Building congress organised by the B— I— N— C— . . . Westminster . . . 1943. Report of proceedings.
11" × 8½". 103 pp. Lond. [1943.] R. (2).

CRESWELL (H. B.) 69.08 : 82—3
*Grig in retirement. [Fictional memoirs of a builder.]
7½". 286 pp. Lond.: Faber & Faber. 1943. 9s. 6d. R. (2).

MATERIALS

D.S.I.R.: FOREST PRODUCTS RESEARCH 691.11 : 634.98 box
Leaflets:
691.11 (4)
No. 31. Foreign timbers—3. &c. 1943.
No. 32. Foreign timbers—4. &c. 1943.
Inf. file 691.11 : 634.98 (41/42)

TIMBER DEVELOPMENT ASSOCIATION
Home-grown timber trees. Their characteristics, cultivation and uses. [By E. H. B. Boulton and B. A. Jay.]
2nd ed. pam. 7¼" × 9¾". Lond. 1942.
Presented by the Association.

CHILDE (H. L.) 691.32 + 693.51
*An Introduction to concrete work. (Concrete series.)
7". viii + 132 pp. Lond.: Concrete Pubns. Ltd. [1943.] 1s. 6d. R. (2).

BRITISH STANDARDS INSTITUTION 69 (083.74)
War emergency British standard:
691.338 : 691.15
1142 . . . Fibre building board for general building purposes.
1943. 2s. R.
Inf. file 691.4 + 693.2

CLAY PRODUCTS TECHNICAL BUREAU OF GREAT BRITAIN
Bulletins: No. 1, 4, 6.
Technical bulletins: No. 3, 5.
Tile hanging. A series of three Infn. sheets &c.
all pam. 11".
Also Information sheets [loose], 4.
leaflets. 12½".
—all Lond. [193— or 194—.] R.
691.71 : 669.1 (06)

IRON AND STEEL INSTITUTE *and* BRITISH IRON AND STEEL FEDERATION
Review of the work of the Joint Research Committees 1924-1943 . . . reporting to the Iron and Steel Industrial Research Council. (I— & S— I—: Special report No. 29.)
8¼". viii + 175 pp. Lond.: Iron & Steel Inst. 1943. R.

CONSTRUCTION

BRITISH STANDARDS INSTITUTION 69 (083.74)
693.068.34 : 620.193
B.s. 1143. Special salt-glazed ware pipes with chemically resistant properties.
1943. 2s. R.

TUBEWRIGHTS, *Ltd.* 693.54 : 693.068.34
Steel tubes for structural work. Specifications and data.
pam. 8o. [Lond. c. 1940-43.] R.
694.1.04

COLLEGE STATION, *Texas*: AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS—TEXAS ENGINEERING EXPERIMENT STATION
*Some fundamentals of timber design. By H. J. Hansen. (Bulletin of the . . . College . . . , 4 S., xiii, 5, 1 May.) (T— E— E— S—, Bulletin No. 66.)
9". 79 pp. College Station. 1942.
Presented by the Station (5).

SANITARY SCIENCE AND EQUIPMENT, PROOFING

696.1 : 614

WOMEN'S GROUP ON PUBLIC WELFARE: HYGIENE COMMITTEE, *and* NATIONAL COUNCIL OF SOCIAL SERVICE
Our towns. A close-up. A study made in 1939-42 with certain recommendations by the H— C— . . . (in association with the N— C— . . .).
Reprint. 8½". xx + 143 pp. Lond., &c.: Oxford U.P. 1943. 5s. P.

MINISTRY OF HEALTH Inf. file 696.11/13 : 940.5344
Water supply. Sewerage and sewage disposal. Post-war works. (Circular 2899.)
leaflet. dupl. t'pt. 8¼". 1943. R.
Inf. file 697 : 662.66 + 697.8 : 620.193.53

BRITISH COAL UTILISATION RESEARCH ASSOCIATION
Presidential address by Sir Evan Williams, . . . 1943. (Document No. C/2551.) [Smoke abatement; domestic fires; research; fuel research.]
dupl. typescript. 10" × 8". 1943. R.
Inf. file 697.8 : 620.193.53 + 697.34

NATIONAL SMOKE ABATEMENT SOCIETY
Proceedings of the 11th annual conference . . . London . . . 1943. Measures for smoke prevention in relation to plans for post-war reconstruction. [Including district heating.]
pam. 8½". n.p. [1943.] 1s. R.

(To be concluded)

Notes

R.I.B.A. Examinations for Prisoners of War

In the early part of 1943 arrangements were made, with the invaluable help of the British Red Cross Society and St. John War Organisation, for holding the R.I.B.A. Intermediate and Final Examinations in a number of prisoner-of-war camps in Germany.

As a special concession the candidates were permitted to take any or all of the subjects of the Intermediate Examination and of the Final Examination with the exception of Design and Professional Practice.

In spite of the many difficulties the examinations were successfully held in four of the camps between March and June.

The following is a list of the successful candidates and the subjects in which they passed :—

INTERMEDIATE EXAMINATION

	Passed.
Oflag IX A/H	
Captain R. G. Bateson.	Whole Examination.
Oflag VII B	
Lieut. J. G. Johnson.	do.
Lieut. S. E. Nicholas.	do.
Lieut. David O' Searle.	do.
Stalag 383	
Cpl. Kenneth E. Foster.	do.
Cpl. John S. Madew.	do.
Stalag Luft 111	
F/O John D. Cordwell.	do.
F/O H. W. Pickstone.	do.
F/Lieut. G. M. Fuller	History of Architecture. Calculations of Simple Structural Members.
F/O Thos. E. P. Ramsay.	History of Architecture Design. Constructional Design.

FINAL EXAMINATION

	Passed
Oflag VII B	
Lieut. P. L. Hansen Bay 2nd-Lieut. Edward J. Scollay Lieut. J. C. O. Stansfield	General Construction Theory of Structures. Hygiene. Specifications and the Properties and Uses of Building Materials.
Stalag Luft III	
F/O Frank S. Knight.	Hygiene.
F/Lieut. Anthony L. Parsons	Hygiene. Specifications and the Properties and Uses of Building Materials.
F/O William R. Samson.	Hygiene. Specifications and the Properties and Uses of Building Materials.

Most of the men concerned have received books to help them with their studies through the special Prisoner-of-War Scheme which is being run by the R.I.B.A. in co-operation with the British Red Cross and St. John War Organisation. Details of this scheme have been published in the JOURNAL from time to time.

Post-War Housing : A Joint Conference

We regret that in the note on p. 92 of the February JOURNAL, referring to the Joint Conference of the R.I.B.A., the National House Builders' Registration Council and the Building Societies' Association, the name of Mr. Hubert Lidbetter [*F.*] was omitted from the list of the R.I.B.A. representatives.

Arthur Louis Aaron V.C. Memorial

As a memorial to Arthur Louis Aaron, V.C., D.F.M., a student of the School of Architecture, Leeds College of Art, it has been decided to create an Aaron Scholarship at the school for Roundhay and other secondary school boys. The Governors of the College of Art appeal for donations towards the capital sum required for the endowment of the scholarship. These should be sent to the Arthur Louis Aaron V.C. Memorial Fund, c/o The Westminster Bank Ltd., Park Row, Leeds. 1.

Secretary to the Royal Fine Art Commission

MR. A. B. KNAPP-FISHER [*F.*] has recently been appointed temporary secretary of the Royal Fine Art Commission in succession to the late H. Chalton Bradshaw [*F.*].

Correspondence Course in Town and Country Planning

A Correspondence Course in Town and Country Planning is being prepared—at the request of the War Office (A.E.3)—by the School of Planning and Research for Regional Development, 32 Gordon Square, London, W.C.1. The course, which is for members of the Forces, is in three parts, each consisting of ten lessons :—

COURSE T.P.1 : BACKGROUND OF PLANNING

1. The modern concept of planning.
2. Topographical and geological structure in relation to planning.
3. Climate in relation to planning.
4. Distribution of population and location of industry.
5. The rural community.
6. The urban community.
7. Thirty years of town planning in Britain.
8. The Barlow Report.
9. The Scott Report.
10. Background to the Uthwatt Report.

*COURSE T.P.2 : PLANNING FACTORS

1. Elements of sociology.
2. History of town planning.
3. Law and administration of planning (including central government).
4. Structure of local government (including rates).
5. Ownership and value of property in relation to planning.
6. Survey for planning : purpose, method, presentation.
7. Transport and communications.
8. Distributive and collective services.
9. Social services and amenities.
10. The physical structure of buildings, roads and utilities.

*COURSE T.P.3 : PLANNING PRACTICE

1. Application of survey and research to planning.
2. National planning.
3. National planning.
4. Regional planning—land use, population and industry.
5. Regional planning—power, transport and communications.
6. Regional planning—community services.
7. Local planning—land use, communications and services.
8. Civic design.
9. Construction and reconstruction—old centres and new towns.
10. Conclusion.

* The titles and order of these lectures are subject to alteration.

The courses are suitable for the following classes of student :—

A. Those who have passed the Final Examination of the Royal Institute of British Architects, the Institution of Civil Engineers, the Institution of Municipal and County Engineers or the Chartered Surveyors' Institution. Students in this class, who satisfy the Directorate of Studies of the School in each of the three courses T.P.1, T.P.2 and T.P.3, will be eligible for admission to the Special Three Months' Completion Course to be organised immediately after the war by the Town Planning Institute for Ex-Service Candidates.

B. Those who hold an educational qualification of matriculation standard and are members of professions, allied to those mentioned under A. For such students these courses will be a suitable preparation for the Intermediate Examination of the Town Planning Institute.

C. Those who are interested in planning subjects, but who do not seek an examination qualification.

It is estimated that the whole course will take nine months to complete ; this is based on the assumption that the student will have three hours spare time per week. It could, however, take less time, or might require more, according to the individual circumstances of the student.

The first course is now available and in circulation.

Applicants should apply to their Education Officer for the necessary enrolment forms, or if they write to the School of Planning and Research for Regional Development, 32 Gordon Square, London, W.C.1 (Euston 2158), their names will be given to the War Office and the forms sent direct to them from there.

The School will also be pleased to give any further information required.

MEMBERS SERVING WITH THE FORCES

THIRTY-NINTH LIST

KILLED

WILSON, HAROLD E. [*A.*], Lieut. R.N.V.R.

PRISONER OF WAR

GREGOR-GRANT, G. [*A.*], Capt. R.E.

AWARDED THE MILITARY CROSS

OXLEY, DERRICK [*A.*], Capt. R.E.
PRICE, T. G. [*S.*], Lieut. R.E.
TREHEARNE, F. P. C. [*S.*], Major R.A.

UNITS AND RANKS OF SERVING MEMBERS

ADAMS, J. T. [*S.*], S/Sgt. R.E.
ADLER, CYRIL [*S.*], Capt. R.E.
ARMSTRONG, J. R. [*S.*], Lieut. R.A.
BAILEY, HAROLD [*S.*], Lieut. R.A.
BAILEY, H. F. [*L.*], Major R.E.
BAILLIE, IAN [*A.*], Lieut. R.E.
BAKER, R. A. [*L.*], Capt. R.E.
BATEMAN, R. WALLACE [*A.*], Major, The Pioneer Corps.
BIDMEAD, G. R. [*A.*], Capt. R.E.
BLOW, R. P. [*S.*], Capt. Queen's Own Hussars.
BOOTHROYD, ERIC [*A.*], Lieut. R.E.
BRAY, A. K. [*S.*], L/Cpl. R.E.
BRIGHT, G. E. [*A.*], Leiut. R.E.
BROODBANK, D. A. [*S.*], A.C.2 R.A.F.
BROUGH, R. W. [*L.*], Lieut. R.N.V.R.
BROWN, T. L. [*S.*], Capt. R.A.
BUDD, F. J. [*S.*], Lieut. R.E.
BUTTLE, DEREK [*S.*], 2nd-Lieut. R.E.
CATHERY, E. L. [*A.*], Lieut. R.E.
CAVANAGH, HOWARD E. B. [*A.*], Major The King's Regiment (3rd Parachute Battn.).
CHAFFIN, A. E. [*L.*], Lieut. R.E.
CHAMBERS, D. P. [*S.*], Pte. P.T.C.
CLARK, FRED. [*S.*], Lieut. R.E.
CLARK, H. R. [*S.*], Q.M.S. R.E.
COCKBURN, G. C. [*S.*], Lieut. Pioneer Corps.
COLQUHOUN, A. H. [*S.*], 2nd-Lieut. R.E.
COOK, L. A. L. [*S.*], Cpl. Glider Pilot Regt.
CORKILL, H. W. [*A.*], Capt. R.A.
CORNE, C. F. [*S.*], L.A.C. R.N.Z.A.F.
COUZENS, H. E. [*S.*], Sgt. R.A.
COX, GEOFFREY [*A.*], Lieut. R.E.
CRAIG, C. N. [*S.*], Lieut. R.E.
CRESSWELL, A. E. [*A.*], Capt. R.E.
CUNNINGHAM, A. [*S.*], Cpl. R.A.F.
DAKIN, A. J. [*S.*], Lieut. South Staffs Regt.
DOBSON, F. C. [*A.*], Lieut. R.E.
DUNTON, G. W. [*S.*], Officer Cadet R.E.
EDE, E. D. [*S.*], Flying Officer R.A.F.
EVANS, F. L. [*S.*], Lieut. Rajput Regt.
FIELDER, D. W. [*S.*], 2nd-Lieut. R.E.
FIELDING, JAMES [*S.*], Cpl. R.E.
FISHER, W. R. [*F.*], Flight-Lieut. R.A.F.
GAYMER, A. D. [*S.*], Capt. R.A.
GERRARD, A. E. [*A.*], Capt. R.E.
GIBSON, B. G. [*L.*], Lieut. R.E.
GOODY, D. G. [*S.*], Lieut. R.A.
GREEN, C. S. [*S.*], Lieut. R.C.S.
HALBRITTER, S. C., Pilot Officer R.A.F.
HALL, HERBERT [*A.*], Lieut. R.E.
HARVEY, DAVID [*A.*], Major R.E.
HASSAN, S. L. [*L.*], Sgt. R.E.M.E.
HAWTHORNE, A. H. [*S.*], Cadet R.A.F.
HAY, GEORGE [*A.*], 2nd-Lieut. R.E.
HELLBERG, ROLF [*F.*], Flight-Lieut. R.A.F. V.R.
HERSHMAN, A. [*S.*], Spr. R.E.
HIRST, P. E. D. [*A.*], Capt. R.A.
HODNETT, A. E. [*S.*], Lieut. R.E.
HORNSEY, K. [*L.*], Pilot Officer R.A.F.
HORSFALL, G. F. [*A.*], Capt. R.E.
HUNT, V. C. [*A.*], Major R.E.
HUTCHINSON, E. O. [*S.*], Lieut. R.E.
JACKSON, C. H. [*A.*], L/Cpl. R.E.
JACKSON, RONALD [*A.*], Capt. R.E.
KEEN, F. J. [*S.*], Spr. R.E.
LAMBERT, R. [*A.*], Capt. R.E.
LEIFER, A. N. [*S.*], Lieut. R.E.
LEVY, ERIC [*A.*], Sgt. R.E.
LOWES, A. J. G. [*A.*], Capt. R.E.
LUTYENS, ROBERT [*F.*], Wing Commander R.A.F.
MCEWEN, F. G. [*S.*], Cpl. R.A.F.
MCKAY, CRAWFORD [*S.*], Lieut. R.E.
MACKINNON, V. G. [*S.*], 2nd-Lieut. R.A.O.C.
MCLAUGHLAN, S. F. [*S.*], Lieut. R.N.V.R.
MCLAUGHLAN, C. P. [*S.*], Lieut. Intelligence Corps.
MCMULLON, S. J. [*S.*], 2nd-Lieut. R.E.
MALLORY, A. L. [*S.*], L.A.C. R.A.F.
MANSON, B. M. [*A.*], Major R.E.
MASTERS, F. G. [*S.*], A.C. R.A.F.
MATTHEWS, A. E. [*S.*], 2nd-Lieut. R.E.
MEACHEY, M. E. [*A.*], 2nd-Lieut. R.E.
MELVIN, JAMES [*A.*], Pilot Officer R.A.F.
MEW, F. J. T. [*L.*], Lieut.-Col. R.A.
MILNES, C. B. K. [*A.*], Lieut. R.A.
MORRIS, WM. [*S.*], Sgt. R.E.
MURRAY, FRANCIS [*A.*], Capt. R.E.
MYERS, DENYS [*A.*], Spr. R.E.
OFFEN, S. E. [*L.*], Spr. R.E.
PENNY, C. R. [*A.*], Sgt. R.A.F.V.R.
PORTER, T. MCE. [*A.*], Tempy. Acting Lieut. R.N.V.R.
REDFERN, E. B. [*A.*], 2nd-Lieut. R.E.
RILEY, W. S. [*S.*], Capt. The Buffs.
RISBRIDGER, H. J. [*A.*], Lieut. R.E.
ROBERTSON, N. M. [*S.*], Sgt. R.A.C.
RUNNICLES, C. G. [*A.*], Major R.E.
SAVEGE, O. F. [*F.*], Capt. R.E.
SCOTT, WILFRID J. [*A.*], Major R.E.
SHANKLAND, C. G. L. [*S.*], Lieut. R.E.
SMITH, WILLIAM [*A.*], L/Cpl. R.A.O.C.
SMYTH, W. G. [*A.*], 2nd-Lieut. R.E.
STEEL, GEORGE [*S.*], 2nd-Lieut. R.E.
STEVENS, KENNETH A. [*A.*], Capt. R.E.
SWANN, PETER W. [*S.*], Officer Cadet R.E.
SYDIE, N. P. [*A.*], Lieut. R.E.
THURSTON, RONALD [*S.*], Lieut. R.E.
TILLETT, C. V. [*A.*], Flight Lieut. R.A.F.
TIMMIS, G. J. [*A.*], Lieut. R.E.
TOOLEY, C. E. [*S.*], Lieut. R.N.V.R.
TUNSTILL, J. B. [*S.*], Cfn. R.E.M.E.
VEREY, D. C. W. [*A.*], Capt. Royal Fusiliers.
WAKEFIELD-BRAND, C. P. [*S.*], Capt. North Staffs Regt.
WALKER, JAMES B. [*S.*], Sgt. R.A.F.
WALKLEY, GAVIN [*A.*], Capt. Royal Australian Engineers.
WALLIS, WILLIAM [*S.*], Lieut. R.E.
WATSON, ALEX. F. [*A.*], Flying Officer R.A.F.V.R.
WHITEHOUSE, J. D. [*S.*], Cpl. Royal Welch Fusiliers.
WIDDAKER, T. J. [*A.*], Lieut. R.E.
WILLIAMS, MORRIS [*A.*], Sub-Lieut. (Special Branch) R.N.V.R.
WRIGHT, J. H. [*A.*], 2nd-Lieut. R.A.
WICKER, FRANK A. [*A.*], Lieut. R.N.V.R.

DISCHARGED ON MEDICAL GROUNDS

HILLIER, N. B. [*A.*].
HORLOCK, L. [*S.*], Spr. R.E.
SHRIMPLIN, C. W. [*A.*], Gnr. R.A.

Membership Lists

ELECTION: APRIL 1944

An election of candidates for membership will take place in April 1944. The names and addresses of the candidates, with the names of their proposers, found by the Council to be eligible and qualified in accordance with the Charter and Bye-laws are herewith published for the information of members. Notice of any objection or any other communication respecting them must be sent to the Secretary, R.I.B.A., not later than Saturday, 15 April.

The names following the applicant's address are those of his proposers.

AS HON. CORRESPONDING MEMBER (1)

AHLBERG: CLAES AXEL HAKON, Blasieholmstorg 11C, Stockholm, Sweden. Proposed by the Council.

AS FELLOWS (12)

ANDREWS: PERCY MAGUIRE [*A.* 1913], Lancaster House, 80 Princess Street, Manchester; 28 The Circuit, Alderley Edge, Manchester. S. Towse, J. H. Markham and H. Passmore.

BEAUMONT: JOHN SOMERVILLE, M.C., B.A. [*A.* 1922], 53 Spring Gardens, Manchester; Moorfield, Disley, Cheshire. H. T. Seward, F. Jones and J. H. Worthington.

HAYWORTH: DUDLEY PARKES [*A.* 1907], 27 Clements Lane, Lombard Street, E.C.4; 38 Forest View, Chingford, E.4. H. P. Gordon, E. Ranger and G. F. Clarkson.

MANT: CECIL GEORGE [*A.* 1929], Ministry of Works (Directorate of Works), Abell House, Westminster, S.W.1; 32 Monkridge, Crouch End Hill, N.8. G. C. Wilson, C. J. Mole and R. F. Dodd.

And the following Licentiates who have passed the qualifying Examination:—

CROSS: MAX GEORGE, 3 Manor Road, Weymouth. A. E. Geens, W. H. Mackenzie and E. Bird.

MORT: ARTHUR EDWARD THOMAS (Major, R.E.), Winchester. A. L. Roberts, H. S. Sawyer and J. C. Shepherd.

OSBORNE: ARTHUR LESLIE, 19 Lansdowne Circus, Leamington Spa. A. G. Brace, B. Oliver and G. B. Hobbs.

SMITH: JOHN MARSH, Council Offices, The Walk, Ebbw Vale, Mon.; "Glaslyn," Avenue Road, Abergavenny, Mon. F. A. Roberts, S. Evans and G. G. Speight.

And the following Licentiates who are qualified under Section IV, Clause 4 (c) (ii) of the Supplemental Charter of 1925 :—

GRIFFITHS : STANLEY ALBERT, Court Chambers, Stourbridge. L. E. Harper, F. W. B. Yorke and D. A. Lumsden.

HAXTON : ANDREW DAVID, Commercial Road, Leven, Fife ; St. Rule, Church Road, Leven. C. G. Soutar, P. H. Thoms and J. D. Mills.

SMITH : STUART VEITCH, Ropergate Chambers, Pontefract, Yorks ; "Annandale," 68 Ackworth Road, Pontefract. J. M. Easton, H. Robertson and J. McL. Bowie.

WRIGHT : WILL JOHN BROCKIE, 26 Blythswood Square, Glasgow ; Moorgate, 23 Whitehall Avenue, Prestwick, Ayrshire. A. G. Henderson, J. Weekes and J. Taylor.

AS ASSOCIATES (36)

The name of a school, or schools, after a candidate's name indicates the passing of a recognised course.

ANDERSON : HARRY (Special Final Exam.], 56 Hartington Grove, Hills Road, Cambridge. L. S. Stanley, H. O. Corfiato and Prof. A. E. Richardson.

BARNETT : MICHAEL [Special Final Exam.], 39 Clive Lodge, Hendon, N.W.4. S. Stern, H. P. Gordon and M. C. Broad.

BARRON : DONALD GABRIEL [Univ. of London], 8 Honeybourne Road, N.W.6. Prof. A. E. Richardson, L. S. Stanley and H. O. Corfiato.

BLACKLOCK : JOHN DONALD [Final], 62 Hurstwood Road, Sunderland, Co. Durham. S. W. Milburn, R. N. MacKellar and W. B. Edwards.

BOOTH : ALAN LEETCHFIELD [Northern Poly., London], 33 Arlow Road, Winchmore Hill, N.21. R. B. Craze, T. E. Scott and H. Banister.

BOSANQUET : Mrs. HILARY JUNE [Arch. Assoc.], 4 Thurloe Street, S.W.7. F. Gibberd, G. Fairweather and R. E. Enthoven.

COIA : JOHN PETER [Glasgow School of Arch.], 88 Drumover Drive, Glasgow, E.1. W. J. Smith, G. Steel and A. Wright.

CROSSLEY : ALAN [Final], 418 Wellington Road North, Heaton Chapel, Stockport. J. G. McBeath, J. P. Nunn and F. Jones.

CROWE : Mrs. SHEILA MARGARITE [Univ. Coll., Dublin], 5 Auburn Avenue, Donnybrook, Dublin, Eire. Applying for nomination by the Council under Bye-law 3 (d).

DALEY : HARRY [Final], 18 Lancaster Gate, W.2. N. Culley, J. Addison and J. T. W. Peat.

DUNAND : Miss AMELIA ETHEL CATHERINE [Special Final Exam.], 55 Morley Road, Twickenham, Middlesex. G. M. Trench, J. Addison and E. Williams.

EARLY : Miss ELEANOR MARY [Final], Elmfield, Witney, Oxon. E. M. Rice, T. L. Dale and T. Rayson.

EDWARDS : JOHN EDWARD GRAEME [Final], "Twenty-four," St. Mary's Road, Harborne, Birmingham, 17. H. Jackson, W. T. Benslyn and B. Walker.

EMMERSON : GEORGE THOMAS [Final], 99 Grainger Street, Park Lane, Darlington, Co. Durham. W. B. Edwards, R. N. MacKellar and F. W. Harvey.

EVANS : Miss JESSIE MAUD MORTON [Royal West of England Academy, Bristol], 117 Ashley Road, Bristol. G. D. G. Hake, E. H. Button and T. A. Skinner.

FARQUHAR : ALEXANDER [Final], 25 Clanrye Drive, Coatbridge. T. J. Beveridge, J. G. Dunn and J. Houston.

GIBBINS : WILLIAM LEIGHTON [Final], 14 Moorland View, Forest Lane, Harrogate. C. M. E. Hadfield, R. Cawkwell and S. Welsh.

GUILD : WILLIAM MALCOLM [Special Final Exam.], "Sunstra," Brighton Road, Cupar, Fifeshire. J. D. Mills, P. H. Thoms and W. Salmond.

HAMILTON : ARTHUR SALMOND [Special Final Exam.], 108 Carmel Road South, Darlington. C. W. Box, G. N. Hill and J. Hughes.

HARRISON : WILLIAM THOMAS [Special Final Exam.], Regent Chambers, Hall Cross, Doncaster. K. Kinna, H. A. Hickson and H. A. Johnson.

HARVEY : Miss GRACE ELIZABETH MURIEL [Special Final Exam.], 22 Lyndhurst Gardens, Hampstead, N.W.3. A. G. MacDonald, R. E. Enthoven and P. Badcock.

HAYMAN : GEORGE ALBERT CHARLES [Final], Heatherstone, 26 Tollards Road, Countess Wear, Exeter. J. Bennett, J. Challice and J. A. Lucas.

HECHT : SAMUEL PHILIPPE ALEXANDRE [Univ. of London], 307 Howard House, Dolphin Square, S.W.1. Prof. A. E. Richardson, H. O. Corfiato and L. S. Stanley.

HUGHES : MAURICE HOWARD [Final], 2 New Way Road, Leicester. W. Brand, A. F. Bryan and J. O. Thompson.

HUNT : BERT RAYMOND, B.Arch. (Dunelm) (King's College [Univ. of Durham] Newcastle-upon-Tyne), The Craiglands, Tunstall Road, Sunderland. W. B. Edwards, W. Milburn and S. W. Milburn.

HUTTON : CHARLES WILLIAM [Univ. of Liverpool], Parkway Chambers, Welwyn Garden City, Herts. Dr. C. Holden, L. G. Pearson and P. V. Mauger.

LOUDON : WILLIAM DOUGLAS [Special Final Exam.], 33 Faskine Avenue, Airdrie. J. M. Arthur, A. N. Malcolm and A. Wright.

MONK : GILBERT LESLIE [Final], 97 Merton Hall Road, Wimbledon, S.W.19. T. E. Scott and applying for nomination by the Council under Bye-law 3 (d).

PAINE : ROBERT WILLIAM, A.R.C.A. [Special Final Exam.], Trebor, South Heath, Gt. Missenden, Bucks. W. G. Newton, H. Anderson and H. C. Ashenden.

PEARCE : GEORGE ALBERT HENRY [Final], "Mayfield," Woodlands Road, Camberley, Surrey. L. H. Bucknell, W. F. Granger and F. Sutcliffe.

POEL : STANLEY BACON [Final], 3 Heath Drive, Gidea Park. J. J. Crowe, H. J. Axten and W. Evans.

REEKS : STANLEY THOMAS CHARLES [Special Final Exam.], 4 Rotherwick Hill, Ealing, W.5. Applying for nomination by the Council under Bye-law 3 (d).

REID : ALEXANDER BUDGE [Final], 27 Windermere Road, Reading, Berks. L. S. Stanley, Prof. A. E. Richardson and H. W. Weedon.

RYDER : JOHN GORDON (King's College [Univ. of Durham] Newcastle-upon-Tyne), 11 Victoria Square, Newcastle-upon-Tyne. W. B. Edwards, Lt.-Col. A. K. Tasker and W. E. Haslock.

SAYCE : GORDON HENRY [Final], 85 Chestnut Rise, Plumstead, S.E.18 J. Addison, E. C. Scherrer and R. F. Reekie.

WYATT : SAMUEL THOMAS [Final], "Steppings," Eastwood Road, St. Anne's Park, Bristol, 4. Sir G. Oatley, J. R. Edwards and E. H. Button.

AS LICENTIATES (16)

CHARLES : MAJOR WILLIAM HENRY, The Salvation Army International Headquarters, 113 Queen Victoria Street, E.C.4 ; 9 Hexham Road, New Barnet, Herts. K. M. Winch, V. J. Esch and H. Sherwood.

FARMER : CYRIL PARSONS, Ministry of Works, Abell House, S.W.1 ; 228 Kidmore Road, Caversham Heights, Reading. C. J. Mole, A. G. Alexander and G. M. Trench.

FARRALL : ARTHUR WILLIAM EDWARD, Ministry of Works, Cleland House, Page Street, Westminster, S.W.1 ; 31 Rodenhurst Road, Clapham Park, S.W.4. Howard Robertson and the President and Hon. Sec. of the Hampshire and Isle of Wight A. A. under Bye-law 3 (a).

GESSEY : LEONARD RICHARD, Ministry of Works, Westminster ; 12 Grennell Road, Sutton, Surrey. E. B. Glanfield, C. J. Mole and A. G. Alexander.

GOODERSON : ARTHUR VIVIAN, 1 Cheyne Court, High Street, Ruislip ; "Greatorex," Bury Avenue, Ruislip. F. H. Mansford, W. L. Eves and H. R. Houchin.

GRAY : LOUIS HENRY, F.S.I., Ministry of Works, Lambeth Bridge House, S.E.1 ; Four Winds, Devenish Road, Sunningdale. C. S. Kimpton, T. P. Bennett and W. L. Eves.

GREENHALGH : HAROLD, P.A.S.I., 15 Mawdsley Street, Bolton, Lancs. ; 206 Bradford Road, Bolton. W. Ellis, R. H. Crook and R. M. McNaught.

HUDSON : MILES WALTER, Ministry of Works, Lambeth Bridge House, S.E.1 ; 9 Northumberland Avenue, Wanstead Park, E.12. A. Thomerson, J. F. Smith and G. M. Trench.

HUDSON : WALTER OAKLEY, 47 Victoria Street, S.W.1 ; 59 Montagu Gardens, Wallington, Surrey. D. Braddell, S. Tatchell and J. Hill.

KIRK : STANLEY LAWRENCE, Messrs. S. C. Phillips & Kirk, Sterling Chambers, 32 Chapel Road, Worthing, Sussex ; 75 Sea Lane, Goring, Worthing. A. Underdown, C. J. Kay and S. T. Hennell.

MCKINLAY : GEORGE, Room 518, South Block, New County Offices, York Road, S.E.1 ; 87 Crown Road, Twickenham. G. W. Smith, J. W. Hepburn and R. Wilson.

MITCHELL : LEONARD PERCIVAL, Architect's Department, L.C.C., County Hall, S.E.1 ; 12 Fernhill Gardens, Kingston-on-Thames. J. W. Hepburn, R. Wilson and B. H. Toms.

MORTIMER : HAROLD, 40 Queensborough Terrace, W.2. A. F. A. Trehearne, T. Overbury and L. W. Barnard.

PONSFORD : HARRY THOMAS, 93, Park Lane, W.1 ; 40 Sedlescombe Road, Fulham, S.W.6. E. Cole, J. B. F. Cowper and applying for nomination by the Council under Bye-law 3 (d).

SMITH : CLARENCE EDWARD, 26 Thornton Road, Bromley, Kent. A. H. Barnes and applying for nomination by the Council under Byelaw 3 (d).

THOMAS : ROWLAND ARCHER, 52 Eastwood Road, Manchester, 10. F. L. Halliday, G. N. Hill and Prof. R. A. Cordingley.

ELECTION : JULY 1944

An election of candidates for membership will take place in July 1944. The names and addresses of the overseas candidate, with the names of two proposers, are herewith published for the information of members. Notice of any objection or any other communication respecting him must be sent to the Secretary, R.I.B.A., not later than Saturday, 24 June, 1944.

The names following the applicant's address are those of his proposers.

AS ASSOCIATE (1)

EMARY: JOHN ELLIOTT, B.A.Arch. (Passed a qualifying Exam. approved by the I.S.A.A.), 83 Somerset Street, Aliwal North, South Africa. Prof. L. W. T. White, J. W. H. Farrow and F. K. Kendall.

ELECTION : FEBRUARY 1944

The following candidates for membership were elected in February 1944:—

AS FELLOWS (3)

DAVIES: DAVID OWEN HARRIS [*A.* 1920], Birmingham.
HUTTON: GEORGE ROY, F.S.I. [*A.* 1936], Oxford.
SYMCOX: EDGAR JOHN [*A.* 1923], Ipswich.

AS ASSOCIATES (17)

CADWALLADER: JOHN DOUGLAS, Sutton Coldfield.
DAVEY: WILLIAM GEORGE HARVEY.
EFROIKEN: MORRIS, Dip.Arch. [Capetown], Capetown.
GATOFF: HENRY, Dip.Arch., Newcastle-upon-Tyne.
HAND: KEVIN P., B.Arch., Dublin.
HARPER: WILLIAM STANLEY.
LYTH: JOHN BURDSALL, Wellington, New Zealand.
MCCORMICK: WILLIAM HENRY DUNLEVY, Dip.Arch. [Lpl.], Londonderry.
MACGOUN: ROBERT GEORGE MAXWELL, B.Arch., Wellington, New Zealand.
MCMAHON: COLM JOHN, B.Arch. [N.U.I.], Dublin.
MATHEW: HUGH PAWLEY, B.Arch. [Rand], Johannesburg.
MEE: HAROLD HENRY MASSEY, Maroubra, N.S.W.
PRICE: HERBERT ERNEST MEREDITH, Umtali, S. Rhodesia.
TAVENER: FELIX WILLIAM, Killara, N.S.W.
TAYLOR: MRS. SHEILA DOUGLAS, Liverpool.
THOMAS: LLEWELLYN.
TIERNEY: LIAM PATRICK, Newry.

AS LICENTIATES (14)

BELL: DOUGLAS, Northallerton.
CAMISH: CYRIL.
CAMPBELL: JOHN WILFRED, Cheltenham.
CHAMPKINS: THOMAS GORDON.
FORD: JAMES FULTON, Edinburgh.
GIDDENS: JOSEPH JONATHAN.
HARDWICK: WILLIAM GEORGE, Chesterfield.
LOWE: BERNARD SIDNEY, Birmingham.
MASON: JAMES FRANCIS.
MORRIS: JOHN CHARLES.
MOSS: CYRIL EDWIN, Salisbury.
RICHARDS: CHARLES ARTHUR.
TOWNSEND: GEOFFREY PAULSON.
VENABLES: WILLIAM GWYN SCALE, Cardiff.

ELECTION : 13 APRIL, 1943

The election of Mr. W. A. Wort as a Licentiate, which was announced in the May, 1943, JOURNAL, has been declared void.

Notices

THE USE OF TITLES BY MEMBERS OF THE ROYAL INSTITUTE

In view of the passing of the Architects Registration Act 1938, members whose names are on the Statutory Register are advised to make use simply of the title "Chartered Architect" after the R.I.B.A. affix. The description "Registered Architect" is no longer necessary.

ASSOCIATES AND THE FELLOWSHIP

Associates who are eligible and desirous of transferring to the Fellowship are reminded that if they wish to take advantage of the next available election they should send the necessary nomination forms to the Secretary R.I.B.A. as soon as possible.

COMPETITION RESULT

Competition for a pair of cottages, promoted by the Women's Institutes of Northamptonshire.

First Prize	..	Percy M. Powell [*L.*].
Second Prize	..	T. H. Tufft [*L.*] and G. M. *Boon* [*A.*].
Third Prize	..	T. F. Winterburn [*A.*] and T. L. *Viney* [*A.*]

Members' Column

PRACTICES

CHANGE OF OFFICE ADDRESS

MR. J. S. THOMSON [*F.*] has transferred his office to 68 Hill Road, Wimbledon, S.W.19. *Tel. No.*: Wimbledon 0194.

FELLOW, aged 41, at present serving as Major R.E., desires to purchase a practice or partnership, with good prospects for post-war work, preferably in or near Liverpool area.—Particulars to Box 2424, c/o Secretary R.I.B.A.

Associate, 30 years old and single, exempt military service, wants partnership in established architectural practice or to develop a post-war practice. No capital available but advertiser possesses ability, initiative and enterprise beyond the average. Reply Box 8244, c/o Secretary, R.I.B.A.

WANTS

WANTED IN GIBRALTAR

Can any member respond to this request from a member in the Garrison Mess, Gibraltar, who writes:

Would it be possible to forward me copies of old periodicals, etc., illustrating the work of the late Sir Edwin Lutyens, P.R.A., and, in particular, one giving sketches in perspective of the new Roman Catholic Cathedral at Liverpool.

Great interest is shown by service men on the Rock in Architecture, Town Planning and kindred subjects, and I had in mind some lectures including one on Lutyens, which, as a member of his staff some years ago now, I should be able to make of great value to many here who will be concerned in building after the war.—G. E. BRIGHT [*A.*] (Lt., R.E.)

WANTED, copies of the following:—*Architectural Review*, 1925 to 1930; *Country Life*, July 1930 to December 1937 (bound volumes preferable); also *Inwood's Tables for Estates*, etc. (late edition), by W. Schooling.—A. N. Holt, 20 Exchange Street East, Liverpool, 2.

WANTED TO PURCHASE, new or second-hand copy of *Colour in Sketching and Rendering*, by A. L. Guptill.—Alan Painter, 12 Hemyock Road, Selly Oak, Birmingham.

WANTED, a recent good condition copy of *A Handbook of Heraldry*, by Fox Davies. State price.—J. H. Bright [*Student*], 24 Angel Hill, Bury St. Edmunds.

Mr. S. B. Caulfield [*F.*], who is retiring from his post of Director of Architecture at the L.C.C. Central School of Arts and Crafts, where he has worked for over 30 years, has taken over the practice of the late Mr. Matthew Dawson, which he will conduct from his office at 27 Emperor's Gate, London, S.W.7 (Western 5353).

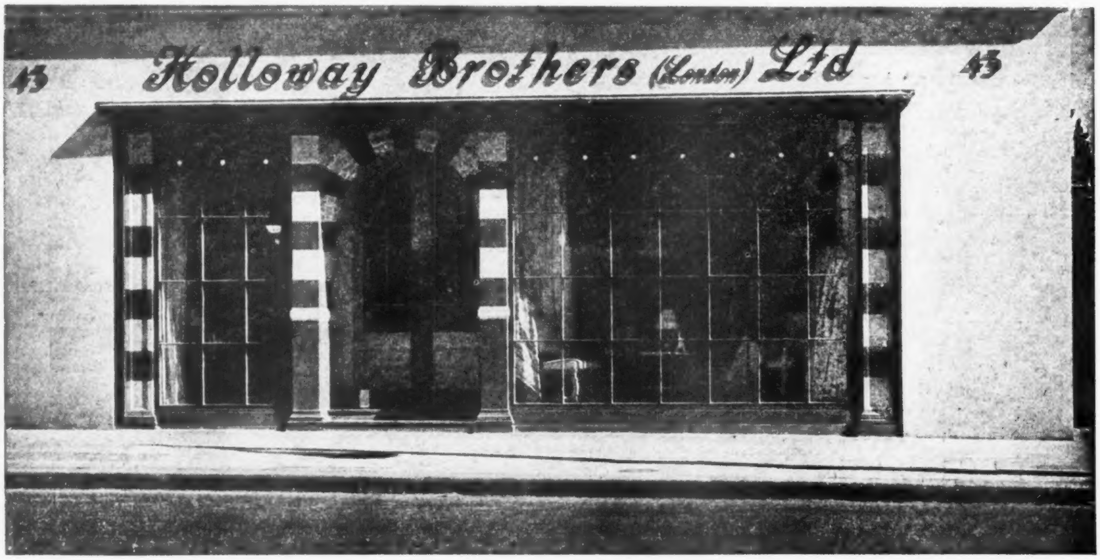
Member would be glad to purchase copies of the following in good condition:—*Town Planning in Practice*, Unwin; *Ancient Town Planning*, Haverfield; *Practical Surveying*, Usill; *Development of Private Building Estates*, Howkins. Reply Box 2924, c/o Secretary, R.I.B.A.

Member wishes to purchase Howkins: Development of Building Estates; Thompson: Site Planning in Practice. New price for copies in normally good condition.—J. C. RICHARDSON, 12, Belmont, Bath, Somerset.

FOR SALE

FOR SALE: case of drawing instruments made by Thornton, Manchester: as good as new, £7 0s. od.—Apply B. A. P. Winton-Lewis, 8 Buckingham Palace Road, S.W.1.

M


43
Holloway Brothers (London) Ltd
43

"Britain's Best Flush Door"

LEADERFLUSH LTD.
TROWELL NOTTINGHAM

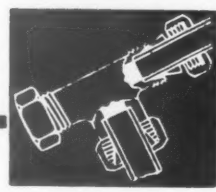
Kontite COMPRESSION *fittings*

For Amphibious Operations

"Kontite" fittings have maintained their outstanding position under extreme war conditions by their adaptability for Aircraft, for Ships, and for shore establishments — Factories, Hostels, Hospitals, Houses and Civil Defence buildings.

SPEED IN ERECTION
SAVE TIME AND LABOUR

Can be used with light-gauge copper or steel tube.



TELEPHONE: BOLTON 197 TELEGRAMS: "KONTITE, BOLTON"

KAY & CO. (Engineers) LTD. BOLTON.

Printed in Great Britain by LOXLEY BROS. LTD., Pixmore Avenue, Letchworth, Herts., March, 1944.

All communications regarding Advertisements in this Journal to be addressed to the Advertisement Department, R.I.B.A., 66 Portland Place, London, W.1. Telephone: Welbeck 3310